CDA 7 5630

Product Manual

DPS7000/XTA
NOVASCALE 7000

Hardware: CDA

REFERENCE
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DPS7000/XTA NOVASCALE 7000

CDA 7 5630

Product Manual

Hardware: CDA

September 1999

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Preface

Scope and Objectives

The CDA 7 subsystem is a very reliable high performance Integrated Cached Disk Array (ICDA) designed for online data storage. The CDA 7 houses both controller and data storage capabilities in a single cabinet.

As part of its effort to continuously improve and enhance the performance and capabilities of the Bull product line, Bull from time to time releases new revisions of CDA 7 5630 hardware and microcode. Therefore, some functions described in this manual may not be supported by all revision of CDA 7 microcode or hardware presently in use.

The document concerns the CDA 7 5630 product, which will be called CDA 7 in the rest of the document.

Where to Get Help

To obtain technical support for your CDA 7 5630, call your local Bull Competence Center.

Intended Readers

This manual is part of the documentation set for the CDA 7 5630 product.

This manual describes the CDA 7 5630 features and operations.

CAUTION:

The CDA 7 5630 contains no user-serviceable parts, so it should not be opened for any reason by untrained persons. If the CDA 7 is in need of repair, only qualified personnel familiar with safety procedures for electrical equipment and the CDA 7 should access components inside the unit.

This manual is intended for the storage administrator, system programmer, or operator who is involved in acquiring, managing, or operating the CDA 7 subsystem.

Prerequisites

For GCOS 7 systems, the CDA 7 subsystem is available with two disk technologies giving two different disk capacities: 18 GB and 36 GB.

18 GB refers to the formatted disk capacity. This is equivalent to an unformatted disk capacity of 23 GB.

36 GB refers to the formatted disk capacity. This is equivalent to an unformatted disk capacity of 47 GB.

Structure

This manual is structured as follows:

Chapter 1	**Introducing CDA 7** provides an overview of the CDA 7 5630, highlighting its performance and reliability features, and describes hardware and software options for the unit.
Chapter 2	**CDA 7 Hardware** introduces the hardware components of the CDA 7 5630. It describes its main components, the function of the operator panel, and the types of host channels and devices to which CDA 7 can attach.
Chapter 3	**CDA 7 Input/Output Operations** discusses integrated cached disk arrays, I/O operation, and cache management.
Chapter 4	**Performance Features** describes the CDA 7 performance features, how they will affect overall performance, and how to use these features to get the best performance from CDA 7.
Chapter 5	**Managing Critical Data** discusses the CDA 7 features that affect data availability and reliability.
Appendix A	**Power Sequences** provides step-by-step instructions for powering the CDA 7 5630 on and off.
Appendix B	**EPS Installation Requirements** covers the tasks you need to perform when planning or verifying the physical configuration of CDA 7 in your system or creating I/O addressing schemes.
Glossary	defines terms used in this manual.
Index	contains an index to help you access the information of interest directly.

Bibliography

Other EMC publications include:

Symmetrix Enterprise Storage Platform Product Guide ..... *P/N 200-999-556, EMC Corporation*
Symmetrix Open Systems Host Environment Product Guide, Volumes I and II ..... *P/N 200-999-563, EMC Corporation*
Symmetrix Remote Data Facility Product GuideP/N 200-999-554, EMC Corporation
SRDF Host Component Product Guide..... *P/N 200-999-561, EMC Corporation*
Symmetrix Data Migration Facility Product Guide ..... *P/N 200-999-559, EMC Corporation*
Symmetrix MultiHost Transfer Facility Product Guide ..... *P/N 200-999-567, EMC Corporation*
Open Symmetrix Manager-Base Component, Product Guide ..... *P/N 200-999-555, EMC Corporation*
Open Symmetrix Manager-SRDF Component Product Guide ..... *P/N 200-999-565, EMC Corporation*
Symmetrix Manager Product Guide..... *P/N 200-999-555, EMC Corporation*
Symmetrix High Availability Environment Product Guide ..... *P/N 200-999-566, EMC Corporation*
Symmetrix Multiple Mirror Facility MVS Batch Utility Product Guide ..... *P/N 200-999-574, EMC Corporation*

Other Bull publications include:

DPS 7000 - Installation Guide - Vol 2 - Peripherals *77 A1 66US*
Bull DPS 7000 - System Repair Manual *77 A7 72US*
CDA/X Product Manual *96 A1 70EC*
CDA 7 Maintenance Manual.....*77 A7 48UU*
CDA 7 5630 Site Preparation..... *77 A1 70UP*

Syntax Notation

Bull uses the following convention for CDA 7 5630 identification:

The CDA 7 5630 uses:

- 3.5-inch 10 000 RPM, disk devices having a formatted capacity of 18 GBytes,
- 3.5-inch 7200 RPM, having a formatted capacity of 36 GBytes

Bull uses the following conventions for notes, cautions, and warnings.

NOTE:
A note presents information that is important, but not hazard-related.

DANGER:
A danger warning contains information essential to avoid a hazard that can cause severe personal injury, death, or substantial property damage if you ignore the warning.

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1. Introducing CDA 7

This chapter provides an overview of the Bull CDA 7 and highlights its performance and reliability features. This chapter also describes hardware and software options.

- CDA 7 Overview
- Channel Configurations
- CDA 7 Options

1.1 Versions of the Product

For GCOS 7 systems, the CDA 7 subsystem is available with two disk technologies giving two different disk capacities: **18 GB** and **36 GB**.

18 GB refers to the formatted disk capacity. This is equivalent to an unformatted disk capacity of 23 GB.

36 GB refers to the formatted disk capacity. This is equivalent to an unformatted disk capacity of 47 GB.

NOTE:
The rest of the document will refer to the18 GB and 36 GB versions.

In the GCOS 7 environment only 18 GB disks or 36 GB disks are used. In the Open Systems environment, when the CDA 7 cabinet is shared either 18 GB disks or 36 GB disks can be used.

1.2 CDA 7 Overview

CDA 7 is a reliable high performance Integrated Cached Disk Array (ICDA) designed for on-line data storage. The following figure provides a front view of the exterior of the CDA 7 model.

Figure 1-1. CDA 7 Cabinet

1.2.1 CDA 7 Capacities

The CDA 7 is available with various numbers of disk devices and storage capacities.

CDA 7 can host both system and user data. In a GCOS 7 environment, disk-modules are 18 formatted capacity. The 18 GB physical disks have to be split into two 9 GB logical disks. The larger capacity models are particularly suitable in a shareable context with Open Systems.

Table 1-1 outlines the CDA 7 model capacities **when the CDA 7 is attached to a DPS 7000 system host**. The capacities are presented based on the method of data protection: RAID-1 Mirroring.

Table 1-1. CDA 7 (RAID-1 Mirroring) Capacities

Marketing Identifier	No of Physical Disks	No of User Disks	Cache (MB)	Total unformatted Capacity of User Disks in GB	Total Formatted Capacity of User Disks in GB	Unformatted Capacity of User Disks in GB Accessible by GCOS 7	Formatted Capacity of User Disks in GB Accessible by GCOS 7
Cabinets							
MSPD056-0000	4	2	1024	46	36	46	36
MSPD057-0000	4	2	2048	46	36	46	36
MSPD058-0000	4	2	4096	46	36	46	36
MSPD059-0000	12	6	1024	138	108	138	108
MSPD060-0000	12	6	2048	138	108	138	108
MSPD061-0000	12	6	4096	138	108	138	108
MSPD062-0000	20	10	2048	230	180	230	180
MSPD063-0000	28	14	2048	322	252	322	252
MSPD064-0000	32	16	2048	368	288	368	288
Disks options for initial configurations							
MSUD050-0000	4	2	-	46	36	0 or 46 *	0 or 36 *
Disks Add-Ons							
MSUD052-0000	4	2	-	46	36	0 or 46 *	0 or 36 *
MSUD053-0000	4	2	-	46	36	46	36

* this value depends on the configuration which receives the Add-On.

1.2.2 Channel Connectivity and Host Integration

The CDA 7 supports connectivity

- To the Bull DPS 7000/GCOS 7 through Ultra SCSI channels,
- To Open Systems, when Enterprise Storage Platform (ESP) software is added, through Ultra SCSI or Fibre channels.

The CDA 7 channel directors are available with the following ports:

- 4-port Ultra SCSI directors,
- 2-port Fibre Channel directors.

CDA 7 supports the Operating System Versions GCOS 7-V7 TS 7560, GCOS 7-V8 TS 8560, GCOS 7-V9 TS9662 and up.

NOTE:
When connected to CDA 7 on Ultra SCSI Channel Director via Ultra SCSI Adapter, Host Systems can use Fast-Wide or Ultra Differential SCSI interfaces.

1.2.3 Performance Features

CDA 7 offers improved performance over conventional Storage Control Units (SCU). These CDA 7 features enhance performance and increase throughput:

- Large non-volatile cache
- Asynchronous I/O
- Multiple storage directors
- Parallel processing
- 100% Fast Write capabilities
- Rotation Position Sense (RPS) miss elimination
- Segmented device-level buffer
- Ultra SCSI channel speeds up to 40 MB/sec
- Fibre Channel speeds up to 100 MB/sec

1.2.4 Availability Features

CDA 7 maintains data integrity and maximizes system availability with these features:

- Redundant architecture
- Full system battery backup
- Dual-initiator
- Redundant power subsystem
- Remote Data Facility (SRDF) option
- Mirroring option
- Non-disruptive component repair (under conditions)
- Non-disruptive microcode upgrades (Limited Case)
- Cache error correction and error verification
- Disk error correction and error verification
- Environmental Fault Reporting
- Error checking, correction and data integrity protection

1.2.5 Serviceability Features

Every CDA 7 unit has an integrated service processor that continuously monitors the CDA 7 environment. The service processor communicates with the Bull Competence Centers via a customer-supplied, direct phone line. It automatically dials the Customer Support Center whenever CDA 7 detects a component failure or environmental violation. A Bull Product Support Engineer at the Bull Competence Center can also run diagnostics remotely via the service processor to determine the source of a problem and potentially resolve it before the problem becomes critical.

CDA 7 has a modular design with a low parts count for quick component replacement should a failure occur. This low parts count minimizes the number of failure points.

The CDA 7 features non-disruptive replacement of its major components, including:

- Channel director cards
- Disk director cards
- Cache cards
- Disk devices
- Cooling fan modules
- Communications cards
- Operator panel
- Power supplies
- Service processor
- Battery

1.3 CDA 7 Options

Bull offers the following hardware and software options for the CDA 7. Consult your Bull Systems Engineer for the latest information on these options.

1.3.1 Hardware Option

1.3.1.1 Phone Multiplexer

Bull offers a Phone Multiplexer for domestic customer sites with multiple CDA 7 units (Integrated Remote Adaptor). The CDA 7 Phone Multiplexer consists of a PBX with a Direct Inward Systems Access (DISA) board set that switches incoming calls to the correct CDA 7 unit. The Phone Multiplexer allows any mix of CDA units to use a common telephone line to communicate with the Bull Competence Center. Each CDA 7 unit has its own extension in the Phone Multiplexer network.

1.3.2 Software Options

The following software options are used:

- Enterprise Storage Platform (ESP)
- Remote Data Facility (SRDF)

1.3.2.1 CDA 7 Enterprise Storage Platform (ESP)

CDA 7 ESP software enabler is a software option that allows simultaneous storage and access of mainframe data and open systems data on the same CDA 7 system. Data must reside on separate physical disks for each platform in the system. Data from multiple system sources may also co-exist on the same CDA 7, both with other open systems data and with mainframe data. Each homogenous operating system environment stores its data on its own physical disks, separate from the physical disks used for data storage by other operating systems.

To implement ESP in your environment, contact your Bull Sales Engineer.

For an example of HACMP in a Sagister/Escala environment, refer to the *CDA/X Product Manual*.

NOTE:
Refer to the *Symmetrix Enterprise Storage Platform Product Guide* for more information on CDA 7 ESP. For information on cluster systems, refer to the *Symmetrix High Availability Environment Product Guide*.

1.3.2.2 CDA 7 Remote Data Facility (SRDF)

The CDA 7 SRDF option is a mechanism that maintains a mirror image of data at a logical volume level in two CDA 7 subsystems that can be located in physically separate sites.

Within the Bull DPS 7000/GCOS 7 environment, the SRDF for GCOS 7 solution is aimed at providing a back-up solution in the situation where a production site is out of work due to a major disaster event. Refer to *§ SRDF for GCOS 7*.

2. CDA 7 Hardware

This chapter describes the main hardware components of the CDA 7 including:

- Major Components
- Operator Panel
- Disk Devices and SCSI Disk Emulation
- Directors and Cache
- Channel Attachments

2.1 Major Components

The CDA 7 is a disk subsystem that houses all Storage Control Unit functions and Disk in a single cabinet. This section describes:

- Component Location
- CDA 7 Block Diagrams

The following figures show the location of the main components of the CDA 7 .

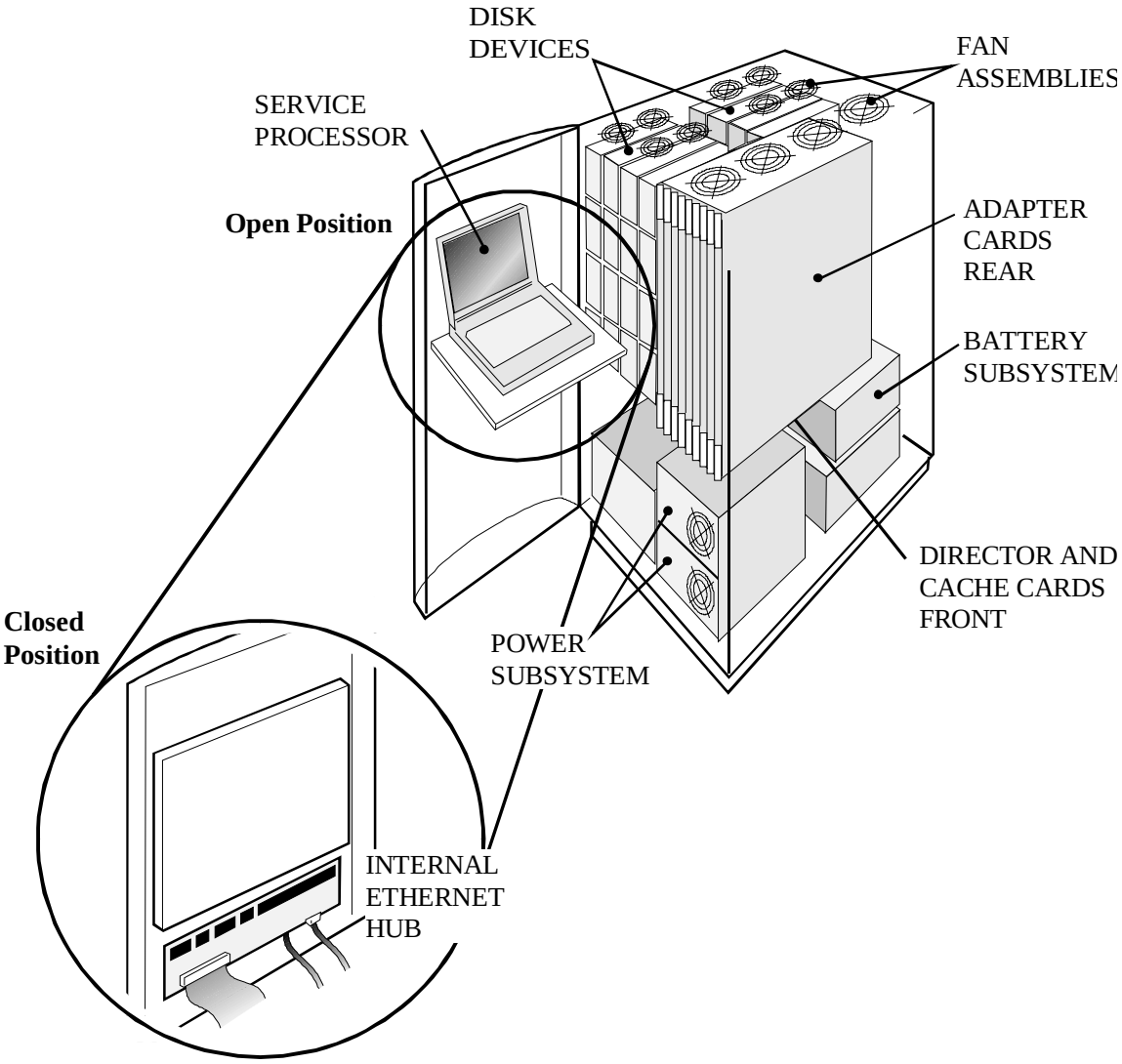


Figure 2-1. CDA 7 (Interior View)

2.1.1 Component Location

These components have the following functions:

Cooling Fan Modules

Contains fans for maintaining air circulation and cooling the unit internally.

Card Cage and Backplane

Contains eight slots to accommodate director, cache, and adapter cards. The directors and cache cards connect to the front of the backplane. The adapter cards connect to the rear of the backplane.

Disk Devices

Contain up to 32 x 3.5-inch disk-devices for data storage.

Bus and Tags Connector Panel

Connectors for bus and tag cables that serve as the external interface to mainframe hosts.

Battery Subsystem

Maintains power for three minutes to the entire subsystem if AC power fails.

Power Subsystem

Two power supplies provide +5V, +12V, and +24V power to the CDA 7 components.

Ethernet Hub

The Ethernet board allows the CDA 7 to communicate with each disk director or channel director. It is located just below the service processor.

Integrated Service Processor

Downloads the CDA 7 configuration to the directors and provides diagnostic and maintenance utilities for CDA 7. It connects to the CDA 7 subsystem via an RS-232 interface and uses an external modem for communicating with the Bull Competence Center when CDA 7 detects an error condition.

Dual Power Cords

EMC offers dual power cords on the CDA 7. This allows you to connect the power subsystem to two dedicated or isolated power lines.

2.1.2 CDA 7 Block Diagrams

The following figure illustrates the interconnection of the major components of the CDA 7 .

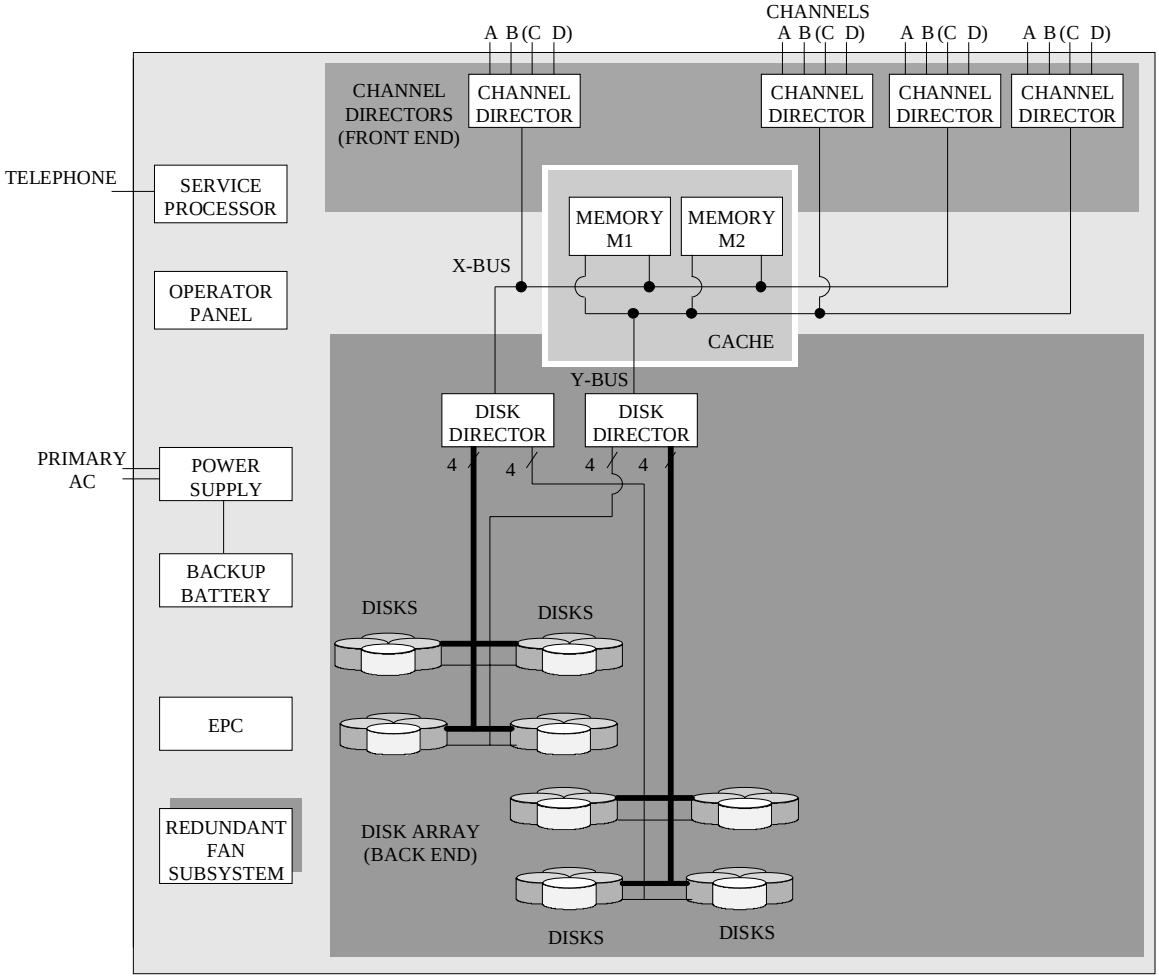


Figure 2-2. CDA 7 Block Diagram

2.2 Operator Panel

This section describes the functions of the various operator panel components.

The CDA 7 operator panel is located at the top of the front door. It has two displays: one for the disk directors and one for the channel directors. The operator panel shows the current activity of each channel director. The following figure shows an example of the operator panel.

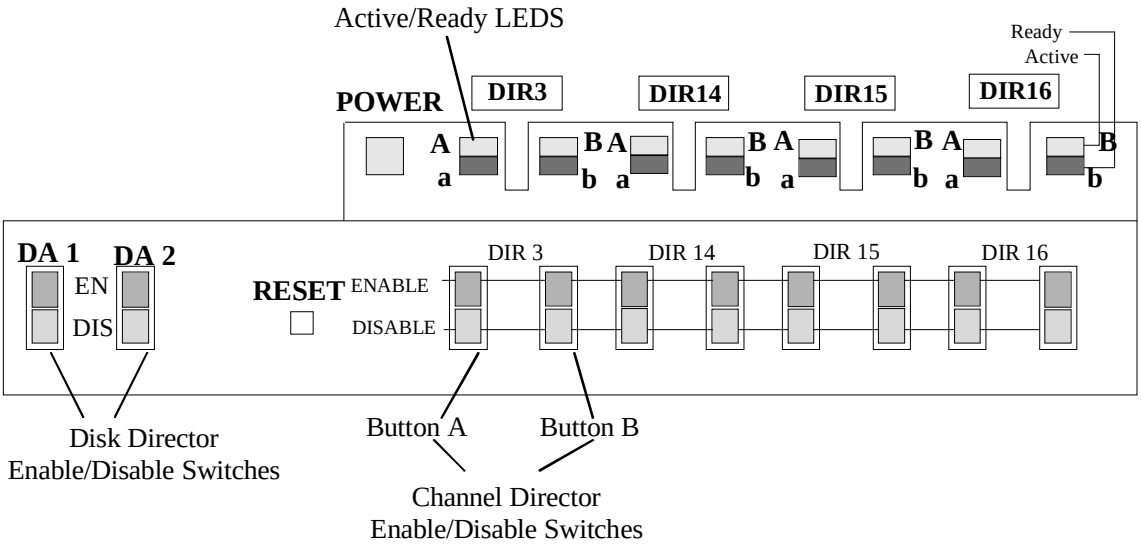


Figure 2-3. CDA 7 Operator Panel

2.2.1 Disk Director Display

The disk director display is located on the left side of the operator panel.

The disk director display has an Enable/Disable switch for each disk director. This switch places the disk director in an on-line or off-line state to the host system. When a switch is in a disabled position, the host system sees all disk devices physically connected to that disk director in a not ready (“Intervention Required”) state the hex display on the disk director indicates “0F”.

2.2.2 Channel Director Display

The channel director display is located on the right side of the operator panel. There is a separate display for each channel director.

The operator panel displays the current activity and status of each channel director. The switches control physical channel on-line/off-line activity.

The channel director display components function as follows for the channel directors:

POWER

Light indicating that the CDA 7 operator panel is powered on.

READY/ACTIVE LED

Light indicating channel interface state. When the Ready/Active LED is lit, that channel interface is on-line to the host system. When the Ready/Active LED is flashing, I/O operations are in progress. For remote link directors (SRDF), these LEDs have no meaning.

ENABLE/DISABLE SWITCHES

Switch for placing a channel interface in the on-line or off-line state.

2.3 Disk Devices and SCSI Disk Emulation

The CDA 7 uses 3.5-inch disk devices, each having an unformatted storage capacity of 23 GB (18 GB formatted). The CDA 7 can contain up to 32 disk-devices.

When using a SCSI interface, the CDA 7 system appears as standard SCSI disk devices with data stored in fixed-block architecture (FBA) format.

The following paragraphs describe:

- the FBA Data and Command Format
- the Logical Volume Structure

2.3.1 FBA Data and Command Format

FBA disk devices store data in fixed sized blocks (typically 512 bytes). A disk device using FBA format is viewed as a large array of blocks. The physical position of the block (cylinder and track) is usually not significant to the host. When requesting disk access for read or write, the host addresses the device by the logical block address (LBA) of the starting block and a count of the total blocks needed. CDA 7 SCSI channel directors and disk directors control access to cache and disk devices, responding to host requests as a standard SCSI disk device.

2.3.2 Logical Volume Structure for GCOS 7 environment

The channel directors interact with cache. Therefore, there is no mechanical meaning to cylinders, tracks, and heads on the CDA 7 logical volume from the front end point of view.

However, CDA 7 uses a logical geometry definition for its logical volume structure. This geometry is reflected in the SCSI mode sense data available to the host.

CDA 7 uses the following logical volume structure:

- Each logical volume has **N** cylinders
- Each cylinder has **15** tracks (heads)
- Each track has **64** blocks of **512** bytes

Therefore, a CDA 7 logical volume with **N** cylinders has a usable block capacity of:

N * 15 * 64

"**N**" for each volume is defined during CDA 7 configuration.

Table 2-1. Cylinders per Logical Volume/or Split Physical Devices

Physical Disk Device Size	2 Logical Volumes per Disk Device
Unformatted capacity of 23 GB Formatted capacity 18 GB (3.5")	18,414 Cylinders **x** 2 8.42 GB2 **x** 2 (9.05 GB10 **x** 2)

To calculate the size of the logical volume:

# of Cylinders * Heads * Blocks * 512

(N * 15 * 64 * 512)

2.4 Directors and Cache

This section describes the CDA 7 directors and cache capacity.

The channel directors and cache manage the storage control functions. The disk directors handle the data storage functions.

2.4.1 Ultra SCSI Channel Director

The Ultra SCSI director is a single card that occupies one slot on the CDA 7 backplane. Each SCSI director interfaces to the host channels via a SCSI adapter connected to the opposite side of the backplane.

The SCSI director has four differential wide interfaces for connection to host systems and one high speed path to cache. The SCSI director contains two advanced microprocessors that process commands and data from the host and manage access to cache. They support data transfer rates up to 40 MB/sec with a host over each channel interface simultaneously. On each SCSI channel director, data transfers from the host to cache occur as four concurrent operations. The CDA 7 can contain two or four SCSI directors.

2.4.2 Fibre Channel Director

The Fibre channel director is a single card that occupies one slot on the CDA 7 blackplane. Each Fibre Channel director interfaces to the host channels via a Fibre Channel adapter connected to the opposite side of the backplane.

These adapters provide the connectivity between the host channel and the Fibre Channel directors (FC-0 layer of the Fibre Channel standard). Each adpater provides transceiver connections for two Fibre Channel ports.

The Fibre Channel director supports a data transfer rate up to 100MB/sec with a host over each channel interface simultaneously.

The CDA 7 can contain two Fibre Channel directors.

2.4.3 SRDF Remote Link Director

The Remote Link Director (RLD) is a 4-port serial channel director microcode configured as the link between CDA 7 units in a CDA Remote Data Facility (SRDF) configuration. CDA requires two RLDs when used in the SRDF for GCOS 7 solution.

NOTE:
For more information, call your Bull Sales Engineer.

2.4.4 Disk Director

The CDA 7 disk director provides an interface between cache and the disk devices. The CDA 7 contains two disk directors. Each director, with its two advanced microprocessors, supports up to sixteen 23 or 47 GB 3.5-inch disk devices— one to four disk devices per SCSI bus (C, D, E, and F).

The CDA 7 supports the following:

	CDA 7
Number of Disk Directors	2
Maximum Number of Disk Devices	32
Number of Buses per Disk Director	4
Maximum Number of Drives per Bus	4
Maximum Number of Drives per Director	16

Each disk director provides an alternate path to the disk devices of its disk director pair. That is, should the primary path through a disk director to a disk device fail, CDA 7 accesses that device through the other disk director in the pair via its dual-initiator function. Refer to *Dual-Initiator Feature* later in this document for more information on this data availability feature.

2.4.5 Cache

Memory is a crucial component of the CDA 7 system. All read and write operations transfer data to or from cache. Any transfers between the host processor, channel directors and cache are achieved at much greater electronic speeds than transfers involving disks. CDA 7 optimizes data movement between disk and cache, resulting in the highest performance possible.

Each cache memory card has two cache buses, x and y, with each having a 360 MB bandwidth for a total processing bandwidth of 720 MB per second. The CDA 7 has two slots dedicated to cache memory. The subsystem supports a maximum of 8,192 MB of cache. Individual cache memory cards are available in 512 MB, and 1 GB, 2 GB, and 4 GB sizes

2.5 Channel Attachments

2.5.1 Ultra SCSI Channel Attachement

CDA 7 can attach to Ultra SCSI channels and Fibre Channels, or a mix of channel types. The physical connection to a CDA 7 SCSI channel interface occurs at the connectors on the channel adapters.

The following figure illustrates the type of SCSI attachments.

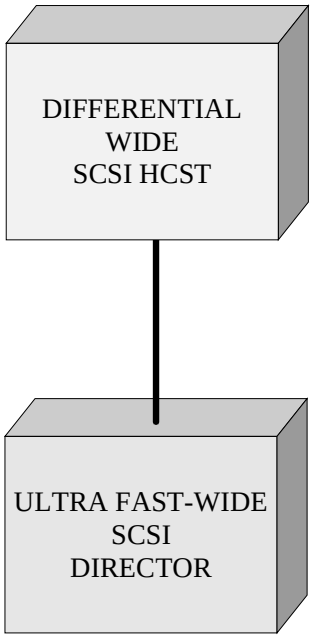


Figure 2-4. ULTRA SCSI Attachment

When connecting to hosts with differential Ultra SCSI interface, use differential P-cables that are designed for wide SCSI applications (see labeling on cable).

With the Ultra SCSI adapters, there are special connecting cables that have a bare part that must be installed in the clamp grounding of the CDA. The switchable port terminations must be set to ENABLE and the corresponding LED is on. The TERMPOWER is set to VCC (the down position).

2.5.2 Fibre Channel Attachments

The CDA 7 Fibre Channel adapter provides an interface between the director and host channels. Each Fibre Channel adapter is located at the rear of the backplane, opposite its corresponding channel director. These adapters provide the connectivity between the host channels and the Fibre Channel directors (FC-0 layer of the Fibre Channel standard). Each adapter provides transceiver connections for two Fibre Channel ports (four directors, eight Fibre Channel ports).

3. CDA 7 Input/Output Operations

This chapter describes input/output operations between the CDA 7 and a host system.

- Integrated Cached Disk Array Operation
- Elements of a CDA 7 I/O Operation

3.1 ICDA Operation

Integrated Cached Disk Array operation is based on the principle that the currently active data at any given time is relatively small when compared to the total subsystem storage capacity. If this data is in cache, there is a significant improvement in performance. The success of an Integrated Cached Disk Array subsystem is based upon satisfaction of the following two characteristics:

Locality of Reference

If a given piece of information is used, there is a high probability that a nearby piece of information will be used shortly thereafter.

Data Reuse

If a given piece of information is used, there is a high probability that it will be reused shortly thereafter.

This cache principle has been in use for years on host systems (CPU and storage devices). The following figure illustrates this type of host cache use. The cache used in this manner is often a high speed, high cost storage unit used as an intermediary between the CPU and main storage.

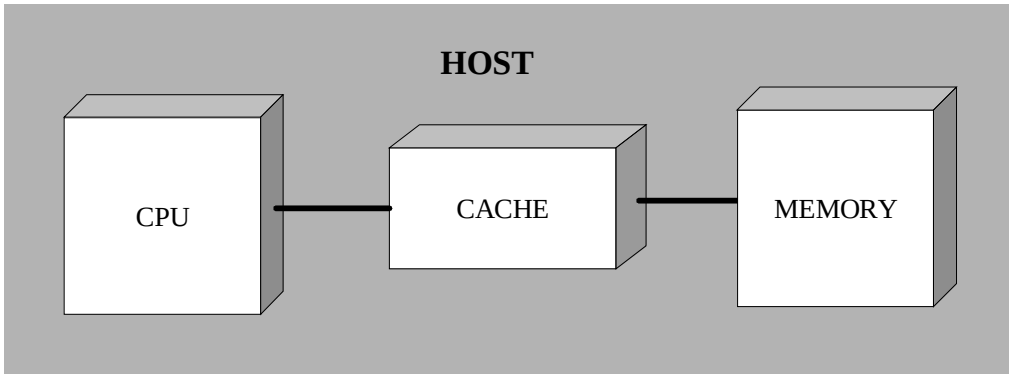


Figure 3-1. Host Cache Use

3.1.1 Cache Management

In CDA 7, the channel directors and disk directors share cache. This cache management is transparent to the host operating system. CDA 7 manages cache using a Least Recently Used (LRU) algorithm and a Prefetch algorithm. CDA 7 dynamically switches between the LRU and Prefetch algorithms to maintain data in cache based on the data access patterns.

3.1.1.1 LRU Algorithm

The directors replace the least recently used data in cache with new data when needed. The LRU algorithm optimizes cache performance through high hit ratios by ensuring that the most appropriate data is stored in cache. The following figure illustrates data flow with the LRU algorithm.

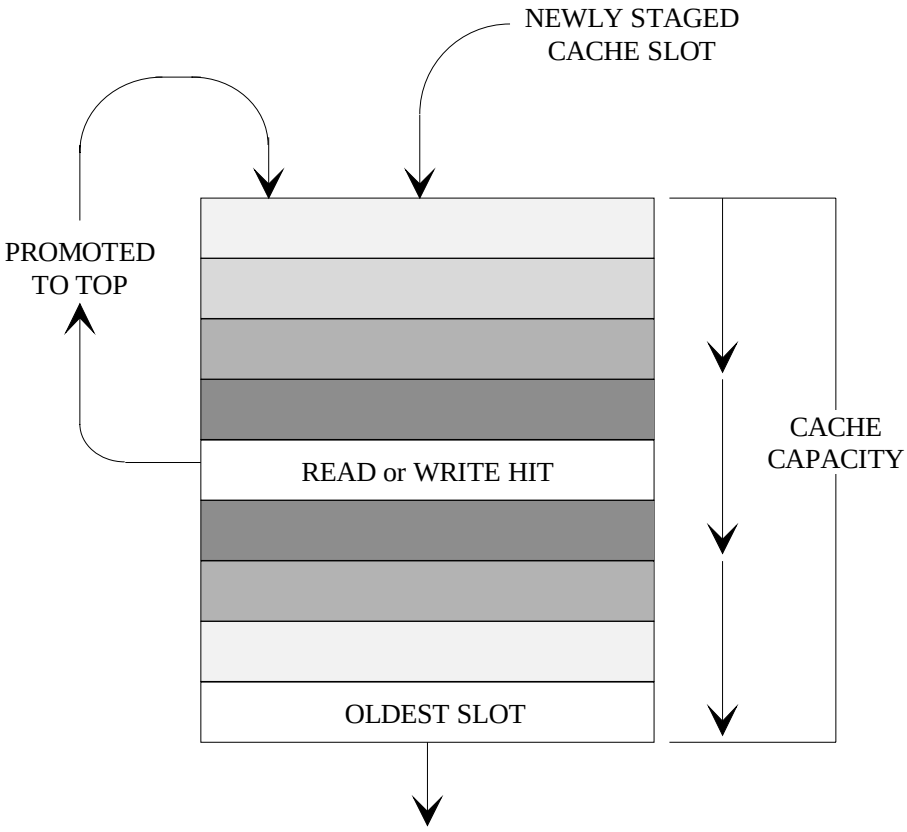


Figure 3-2. LRU Data Flow

Each time a read hit or write hit occurs, CDA 7 marks that cache slot as most recently used and promotes it to the top of the LRU list. For each write, a written-to flag is set on the initial write to each cache block and is cleared when the cache block is "destaged". At the bottom of the LRU list is the least recently used cache slot.

3.1.1.2 Prefetch Algorithm

The Prefetch algorithm dynamically detects sequential data access patterns to the disk devices. The directors improve the hit ratio of these accesses by promoting blocks from the disk devices to cache slots before a read miss can occur.

The Prefetch algorithm can stage between a single block and a full track of data to a cache slot. The LRU algorithm adds the cache slot to the top of the LRU list. To make room for these tracks, CDA 7 removes slots at the bottom of the list from cache.

3.1.2 Caching Techniques

CDA 7 uses the same cache principle as host systems, but with enhanced caching techniques. The following figure illustrates cache use in CDA 7.

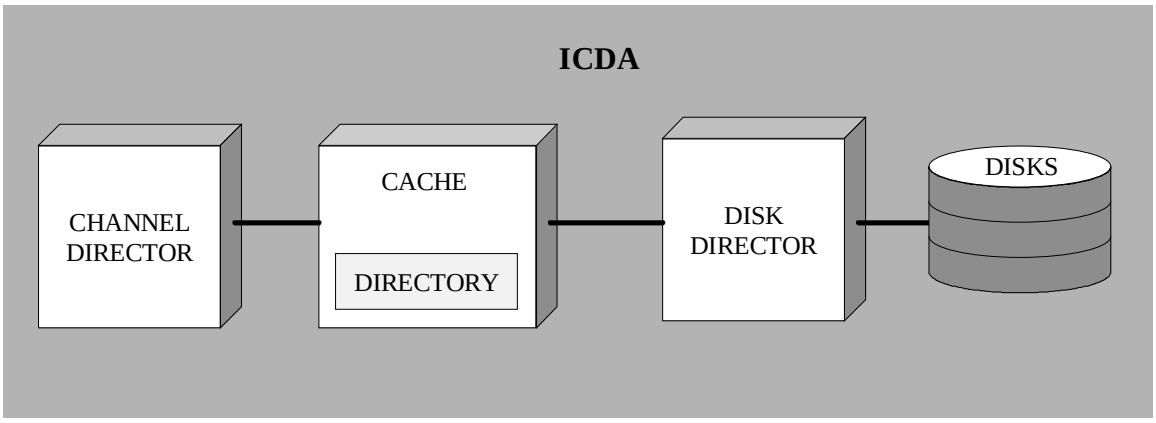


Figure 3-3. CDA 7 Cache Use

CDA 7 directors handle either channel or disk operations. Channel directors attach to the CPU channels as well as to cache. Disk directors attach to cache as well as the disk drives. The CDA 7 directors perform the following functions:

- The channel director handles I/O requests from the host. It accesses the directory in cache to determine if the request can be satisfied out of cache. The directory contains information on each cache slot and the blocks within each slot. It maintains data in cache based on the data access patterns.
- The disk director manages accesses to the disk drives. It performs a background operation that "destages" “written-to” blocks to disk.

CDA 7 uses these techniques to enhance its performance:

Split Director Functions The director operations are split into two functional parts, the channel director and disk director. The channel director services requests from the host. The disk director services requests between cache and disk. Splitting the director functions eliminates the processing overhead and cache locking associated with Control Units that perform both functions.

High Speed Cache Memory
Cache memory speed is greater than the total speed of all components (e.g., the directors) that access it.

Disk Microprocessor and Buffer
Each disk device has its own microprocessor and buffer. This intelligence is brought to the actuator level providing parallel processing of data. These features add another level of caching and improve overall performance.

Multiple Disk Directors A maximum of 16 disks (CDA 7 models) attach to each disk director. For more information on director and disk combinations, refer to *Disk Director* earlier in this document.

Sequential Access Patterns
Access patterns can be sequential, random, or a combination of both. When a miss occurs on a sequential access pattern, the number of blocks brought into cache is increased, thus improving the hit rate (requested data is in cache).

3.2 Elements of a CDA 7 I/O Operation

All I/O operations require a certain response time. An I/O request begins with the application issuing an I/O command and ends when the transfer completes. The time lapse from I/O request to transfer completion is the I/O response time.

3.2.1 I/O Response Time

The I/O response time can be divided into a host queuing time, a command connect time, a disconnect time, and a data connect time, as shown in the following figure.

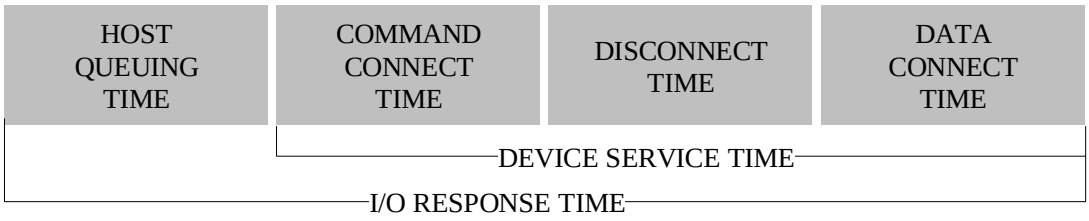


Figure 3-4. I/O Response Time

The **Host Queuing Time** is the time the request is in the host queue before it is dispatched on the SCSI bus.

The **Command Connect Time** is the length of time the channel is transferring a SCSI command.

The **Disconnect Time** is the length of time involving device seek and latency. At this time the SCSI bus can be used by other devices.

NOTE:
In case of a cache hit in an I/O request, the Disconnect Time requirement is eliminated.

The **Data Connect Time** is the length of time the channel is transferring data.

There are four basic types of CDA 7 I/O operations:

- Read Hit
- Read Miss
- Fast Write
- Delayed Fast Write

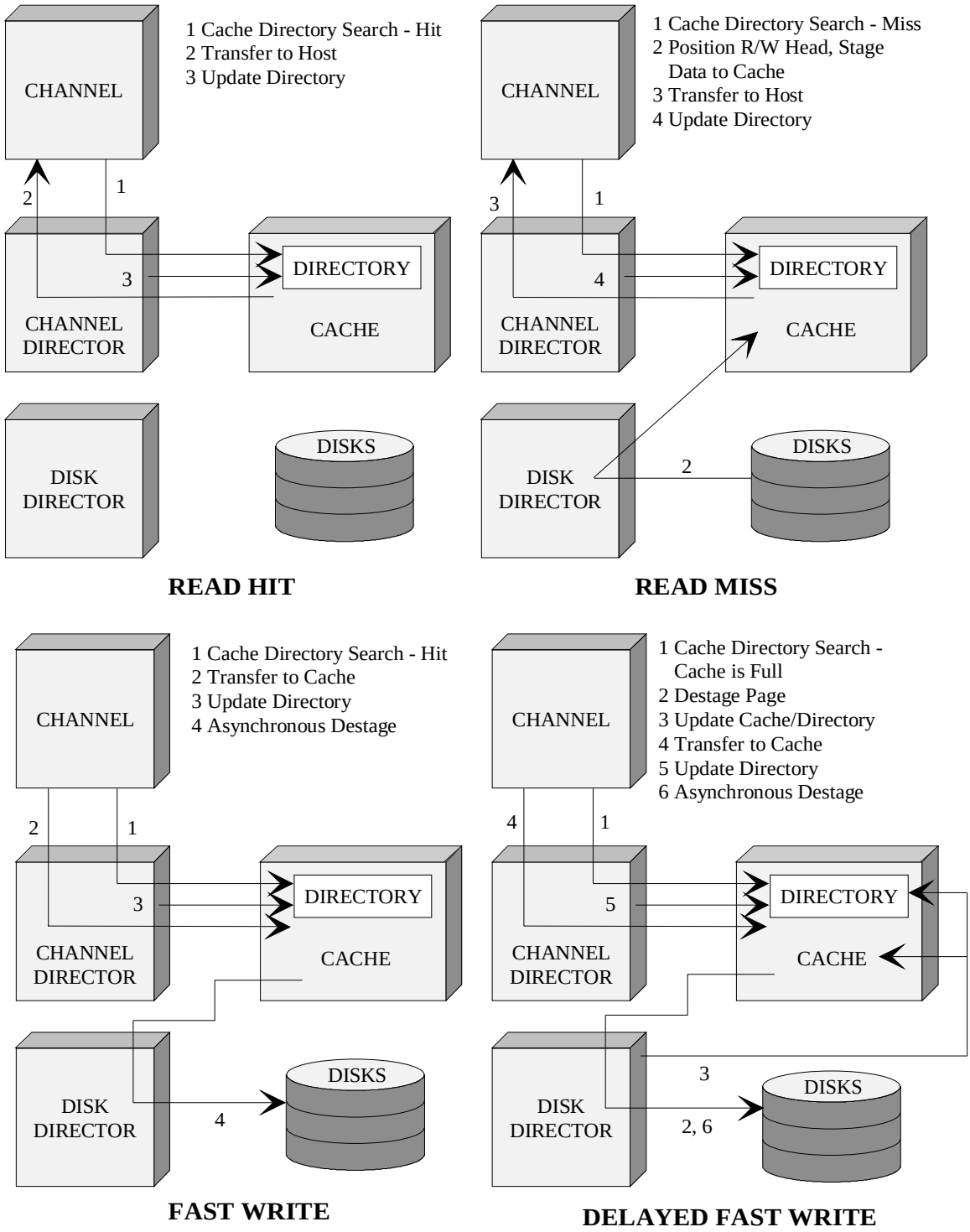


Figure 3-5. Types of CDA 7 I/O Operations

In addition to the four types of I/O operation mentioned, CDA 7 performs a background operation that "destages" "written-to" blocks back to disk. The following figure illustrates this "destaging" operation.

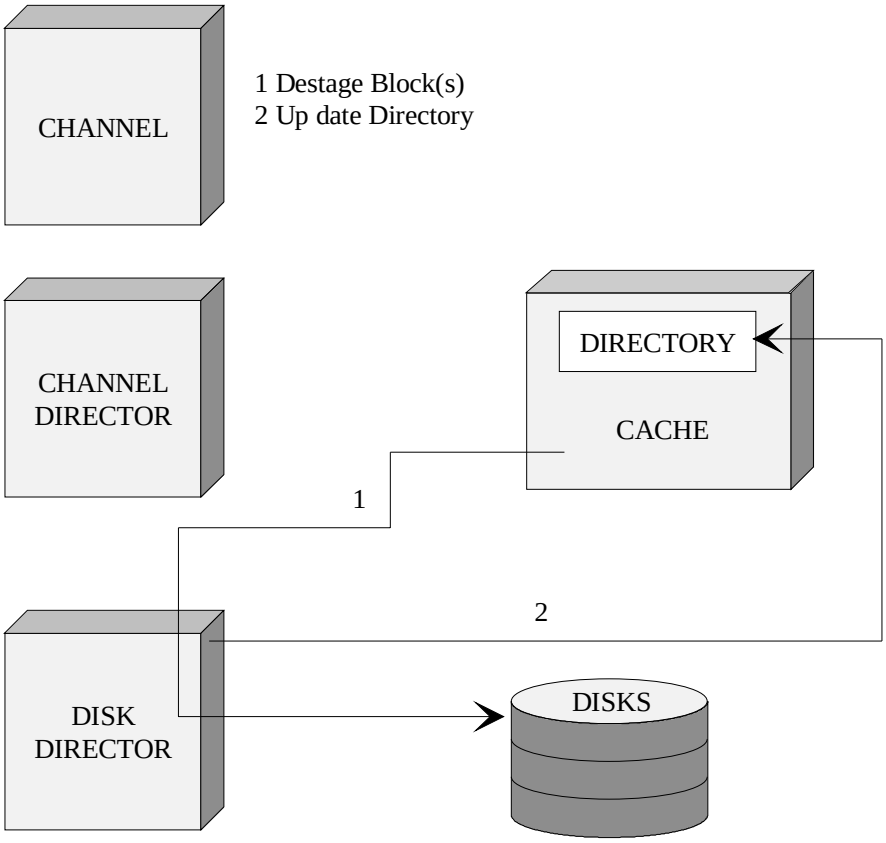


Figure 3-6. Destaging Operation

CDA 7 performs read operations from cache. CDA 7 always caches write operations. This cache operation is transparent to the host operating system. A read operation causes the channel director to scan the cache directory for the requested data. If the requested data is in cache, the channel director transfers this data immediately to the channel with a channel end and device end (or a SCSI good ending status). If the requested data is not in cache, the disk director transfers the data from the disk device to the cache and the channel director transfers the requested data from the cache to the channel.

3.2.2 Read Operations

There are two types of read operations: read hit and read miss. The following figure illustrates the data flow for read operations.

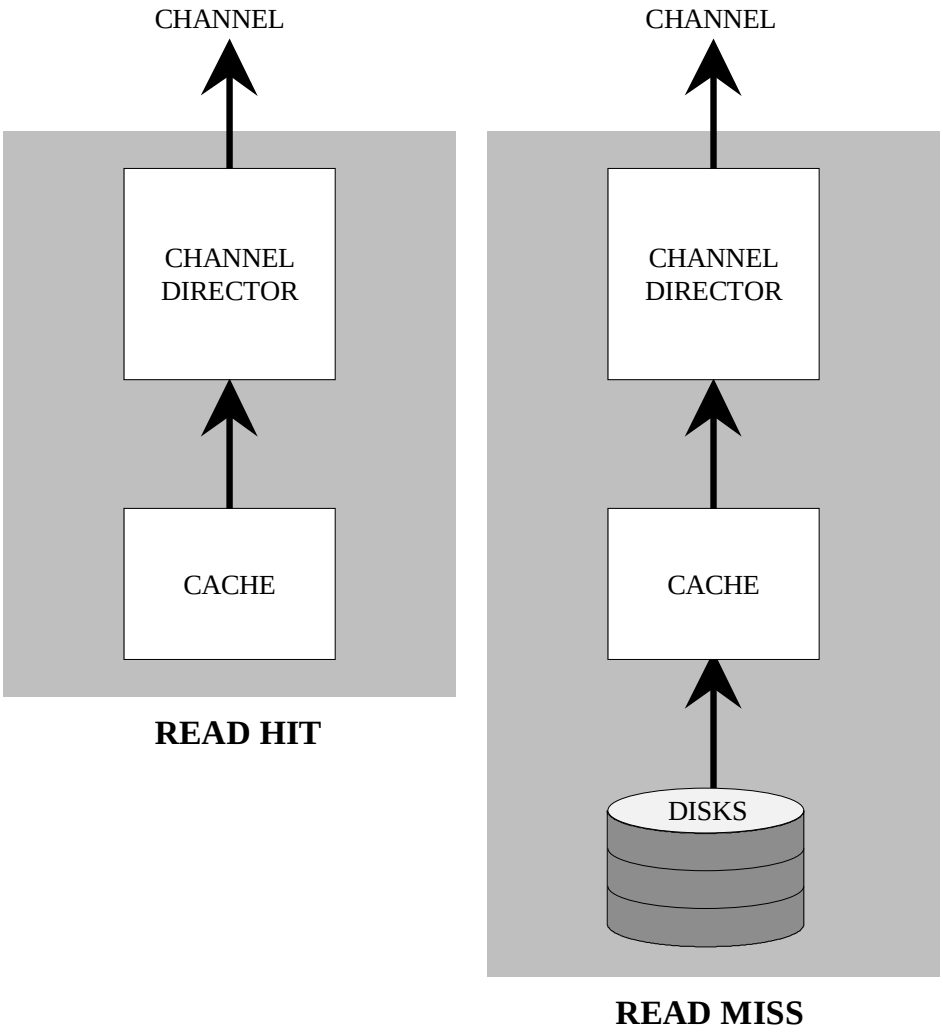


Figure 3-7. Read Operations

3.2.2.1 Read Hit

In a read hit operation (following figure), the requested data resides in cache. It is transferred directly to the host computer through the channel interface.

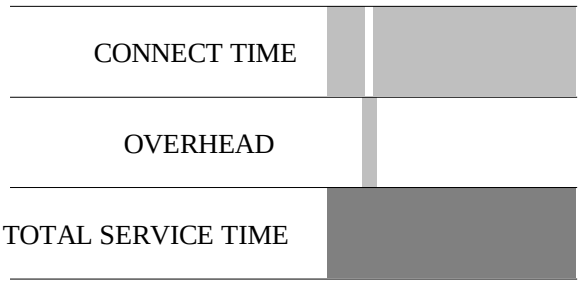


Figure 3-8. Read Hit

Since the data is in cache, there are no mechanical delays due to seek, latency, and RPS miss.

3.2.2.2 Read Miss

In a read miss operation, the requested data is not in cache and must be retrieved from a disk device. While the channel director creates space in the cache, the disk director reads the data from the disk device. The disk director stores the data in cache as the channel director simultaneously transfers the cached data to the host. If the requested data is in the process of being pre-fetched (sequential read ahead), the miss is considered to be a "short miss." If the requested data is not in the process of being fetched, it goes on a list to be fetched and the miss is considered to be a "long miss."

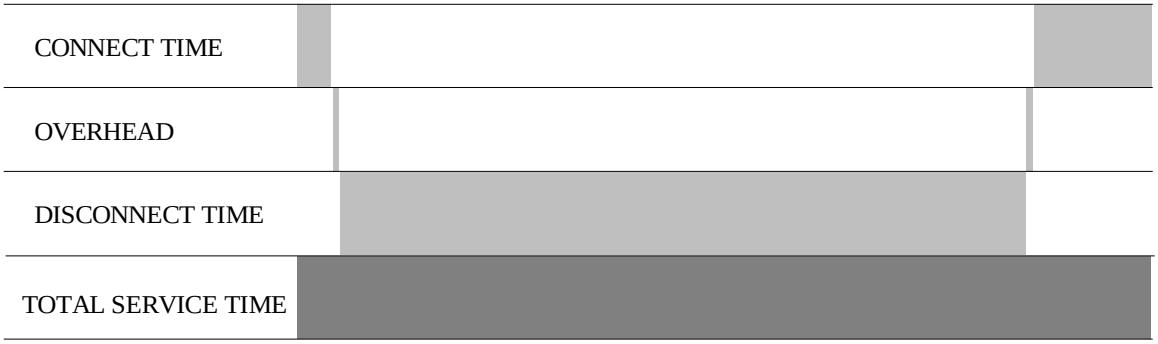


Figure 3-9. Read Miss

Since the data is not in cache, CDA 7 must search for the data on disk and then transfer it to the channel. This adds seek and latency times to the operation. During the disconnect time, other commands can be executed on other devices on the bus, or commands can queue to the same device.

3.2.3 Write Operations

For write operations, the channel director sends a device end and channel end (or a SCSI good ending status) to the channel as soon as the data is in cache and verified as error-free so the host system can continue processing without having to wait for CDA 7 to write the data to disk. The disk director asynchronously "destages" the data to disk.

There are two types of write operations:

- Fast Write
- Delayed Fast Write

The following figure illustrates the data flow for write operations.

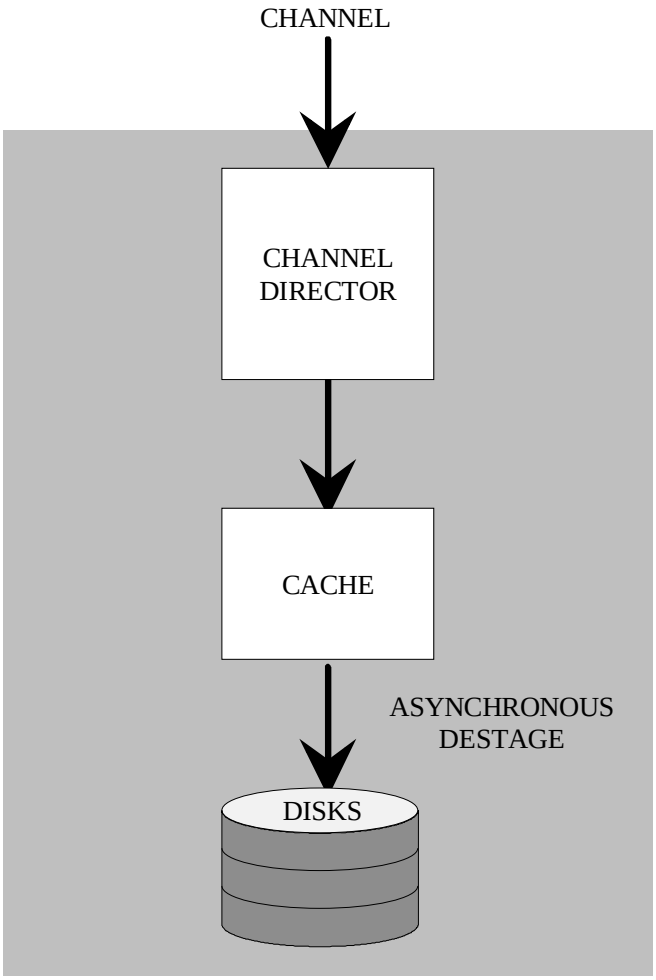


Figure 3-10. Write Operations

3.2.3.1 Fast Write

In a fast write operation, the channel director stores the data in cache and sends a channel end and device end (or a SCSI "good ending" status) to the host computer. The disk director then asynchronously "destages" the data from cache to the disk device.

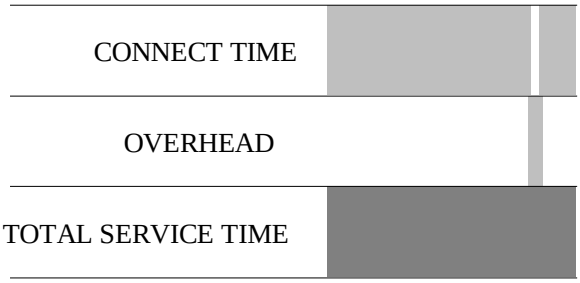


Figure 3-11. Fast Write

Since CDA 7 writes the data directly to cache and not to disk, there are no mechanical delays due to seek, latency, and RPS miss.

3.2.3.2 Delayed Fast Write

In a delayed fast write operation, CDA 7 cannot store the data in cache until space in cache becomes available. A delayed fast write condition can only happen if the cache allocated for writes is currently full with data yet to be "destaged" to the disk devices. The default cache write ceiling is 80% of the cache.

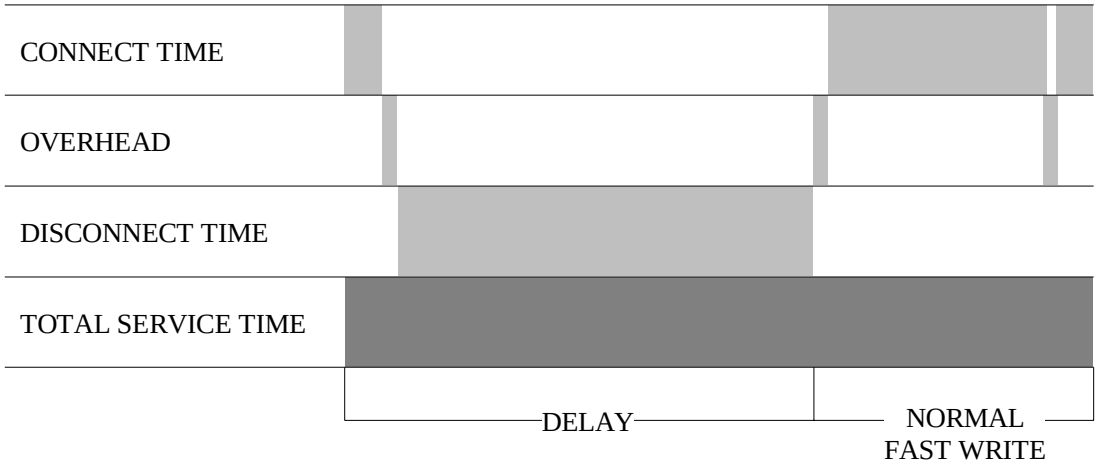


Figure 3-12. Delayed Fast Write

Should this situation occur, CDA 7 disconnects the channel directors from the channels and waits for the disk directors to "destage" the Fast Write data in cache to disk. When space in cache is available, CDA 7 reconnects the channel directors to their channels and completes the write operation. CDA 7 continues to process read operations during delayed fast writes.

4. Performance Features

CDA 7 offers improved performance over conventional Storage Control Units and disk device designs. The CDA 7 features described below allow high cache hit ratios and less processing overhead, reducing response time and improving throughput.

4.1 Cache

A cache size of up to 8,192 MB and intelligent caching algorithms greatly improve hit ratios and overall subsystem response time. CDA 7 caches all read and write operations making them transparent to the host operating system.

4.2 Multiple Channel Directors

CDA 7 contains multiple channel directors, Ultra SCSI or fibre channel type, each supplying an independent path to cache or disk from the host system. The CDA 7 has two or four channel directors.

Each Ultra SCSI director supports up to four SCSI channels.

Each fibre channel director supports two Fibre channel ports.

4.3 Parallel Processing

Each channel director and disk director has two resident microprocessors, and each disk device has one resident microprocessor. These microprocessors make use of advances in parallel processing to reduce processing time and improve throughput.

4.4 Fast Write Capabilities

CDA 7 caches write operations, eliminating the need to write data to the disk immediately. This results in faster response times and improved overall subsystem performance. The write ceiling is 80% of the usable cache. Channel directors and disk directors dynamically allocate cache space between reads and writes depending on I/O activity.

4.5 Dynamic Mirror Service Policy

The CDA 7 Dynamic Mirror Service Policy (DMSP) is an enhancement to the adaptive algorithms in the CDA 7 architecture that improves the performance of read operations in mirrored environments. The improved system performance is a result of CDA 7 balancing the load between physical disk drives and disk directors, and minimizing actuator movement.

To achieve this improved performance, CDA 7 measures and tracks I/O activities of logical volumes, physical volumes and disk directors. Then, based on these measurements, CDA 7 directs read operations for mirrored data to the appropriate mirror that results in the best overall performance of the CDA 7 . As the access patterns and workloads change, the dynamic algorithm analyzes the new workloads and adjusts the service policies as needed.

4.6 RPS Miss Elimination

In CDA 7, each disk device has a dedicated microprocessor and segmented data buffer that can temporarily store data until the disk director is ready to read or write data. This eliminates rotational positional sensing (RPS) misses that occur in conventional disk device when the heads are positioned over the desired sector, but the channel path is not ready for read or write operations. The segmented data buffer of the disk device allows multiple operations to occur to the head/disk assemblies.

4.7 Channel Speed

CDA 7 Ultra SCSI channels transfer data at speeds up to 40 MB/sec. The data transfer rate is host dependent. CDA 7 supports cable lengths of up to 82 feet (25 m) to attach to most host systems.

5. Managing Critical Data

This chapter discusses the CDA 7 features and options that affect data availability and reliability.

- CDA 7 Data Management Overview
- Reliability and Availability Features
- Data Integrity Protection
- Data Protection Guidelines
- Mirroring

5.1 CDA 7 Data Management Overview

CDA 7 has many features and options to ensure a high degree of system and data availability.

Many of these features and options are built into the CDA 7 design. Other availability options may be purchased separately and implemented in the CDA 7 operation.

5.1.1 CDA 7 Reliability and Availability Features

The CDA 7 design offers the following reliability and availability features:

- High reliability components
- Redundant power subsystem
- System battery backup
- Dual-Initiator feature
- Non-disruptive maintenance and microcode upgrades

These basic CDA 7 features provide protection against loss of system and data availability due to a power loss or failed component. A redundant design allows CDA 7 to remain online and operational during component repair. For example, if a power supply fails, the remaining power supplies share the load until the failed component is replaced. The system battery backup prevents any loss of data due to a power failure.

The Dual-Initiator feature offers data availability protection against a CDA 7 disk management component failure. With dual-initiator, each member of a disk director pair shadows the functions of the other disk director. That is, each disk director can service any or all of the devices attached to the disk director with which it is paired. This feature does not, however, provide data availability in the event of a disk device failure. Should CDA 7 detect a disk management hardware failure, CDA 7 automatically reads from or writes to the disk devices it was unable to communicate with via the other disk director in the pair.

5.1.2 CDA 7 Data Integrity Protection Features

The CDA 7 is designed with these data integrity features:

- Error checking, correction, and data integrity protection
- Disk error correction and error verification
- Cache error correction and error verification
- Periodic system checks

Error verification prevents temporary errors from accumulating and resulting in permanent data loss. CDA 7 also looks at the error verification frequency as a signal of a potentially failing component.

The periodic system check tests all components as well as microcode integrity. CDA 7 reports errors and environmental conditions to the host system as well as the Bull Competence Center.

5.1.3 Data Protection Options

Although the CDA 7 has standard features that provide a higher level of data availability than conventional disk, the options listed below ensure an even greater level of data recoverability and availability.

You can choose from the following CDA 7 data protection options to match your critical data requirements:

- RAID-1 Mirroring
- CDA 7 Remote Data Facility (SRDF)

5.1.3.1 RAID-1 Option (Mission Critical/ Business Critical)

Mirroring provides the highest performance, availability, and functionality for all mission critical and business critical applications. With the Mirroring option, CDA 7 maintains two identical copies of a logical volume on separate disk devices. Should CDA 7 be unable to read data from one volume of a mirrored pair, it immediately retrieves the data from the other logical volume.

5.1.3.2 CDA 7 Remote Data Facility (SRDF)

The CDA 7 SRDF option is a mechanism that maintains a mirror image of data at a logical volume level in two CDA 7 subsystems that can be located in physically separate sites.

Within the Bull DPS 7000/GCOS 7 environment, the SRDF for GCOS 7 solution is aimed at providing a back-up solution in the situation where a production site is out of work due to a major disaster event. Refer to *§ SRDF for GCOS 7*.

5.2 Reliability and Availability Features

CDA 7 has several features that allow it to maintain data integrity and maximize system availability. This section discusses several features in detail.

5.2.1 Reliable Components

CDA 7 uses components that have a mean time between failure (MTBF) of several hundred thousand to millions of hours for a minimal component failure rate. A redundant design allows CDA 7 to remain online and operational during component repair.

A periodic system check tests all components as well as microcode integrity. CDA 7 reports errors and environmental conditions to the host system as well as the Bull Competence Center.

5.2.2 Redundant Power Subsystem

The CDA 7 has a modular power subsystem featuring a redundant architecture that facilitates field replacement of any of its components without any interruption in processing.

The CDA 7 power subsystem connects to two dedicated or isolated AC power lines. If AC power fails on one AC line, the power subsystem automatically switches to the other AC line.

The two power supplies operate in a redundant parallel configuration. If a power supply module fails, the remaining power supply continue to share the load. CDA 7 senses the fault and reports it as an environmental error (error code 0472).

5.2.3 System Battery Backup

The entire CDA 7 system is made nonvolatile via an onboard battery backup system. The battery backup system provides the means for destaging any fast write data that might be in cache if AC power is lost on both AC power lines to the unit. In addition to providing nonvolatility to the CDA 7 system, the batteries are fully capable of powering not only all electronic components, but also all HDAs during this time. This eliminates emergency power off situations, meaning that the disks are always powered down in an orderly manner, which extends their useful life considerably.

The backup battery subsystem allows CDA 7 to remain online to the host system for three minutes in the event of an AC power loss. This three minute window allows CDA 7 to support frequent power outages because the battery is able to fully recharge during Initial Microcode Load (IML) time. CDA 7 continually recharges the battery subsystem whenever it is under AC power.

The battery backup also prevents disk device failures due to the sharp power drops that occur during unexpected power interrupts. If power is restored before the battery timer expires, CDA 7 becomes available again without IML.

5.2.3.1 CDA 7 Power Failure on GCOS 7 Channels Connected to GCOS 7

When a power failure occurs, power switches immediately to the backup battery and CDA 7 continues to operate normally. When the battery timer window elapses, CDA 7 presents a busy status to prevent the host system from writing or reading any data at the unit. CDA 7 destages any Fast Write data still in cache to disk, spins down the disk devices and retracts the heads, and powers down, turning off the battery at that time. CDA 7 will not respond to SCSI selections after it powers down.

5.2.4 Dual-Initiator Feature

CDA 7 has a dual-initiator feature that ensures continuous availability of data in the unlikely event of a CDA 7 disk management hardware failure. It does not provide data availability in the event of a disk device failure. This feature works by having two disk directors “shadow” the function of the other. That is, this feature gives each disk director the capability of servicing any or all of the disk devices of the disk director with which it is paired when one disk director is completely servicing its own and the shadowed devices.

With dual-initiator, the disk directors work in pairs. See the figures on the following pages. Under normal conditions, each disk director services its disk devices. If the sophisticated fencing mechanisms of CDA 7 detect a disk management hardware failure, CDA 7 notifies the host and the Bull Competence Center of the failure, and reads from or writes to the disk devices that its disk director pair was unable to communicate with without interruption. When the source of the failure is corrected, CDA 7 returns the I/O servicing of the two disk directors to their normal state.

This sophisticated fencing mechanism determines a disk management hardware failure at two levels:

Level 1: a director discovers through use of its online self-testing that one of its SCSI paths is failing. The director signals CDA 7 of this condition and the director it is paired with automatically takes control of the failing path.

Level 2: CDA 7 determines a director has failed and fences it out. The director's associated pair automatically takes control of all its devices.

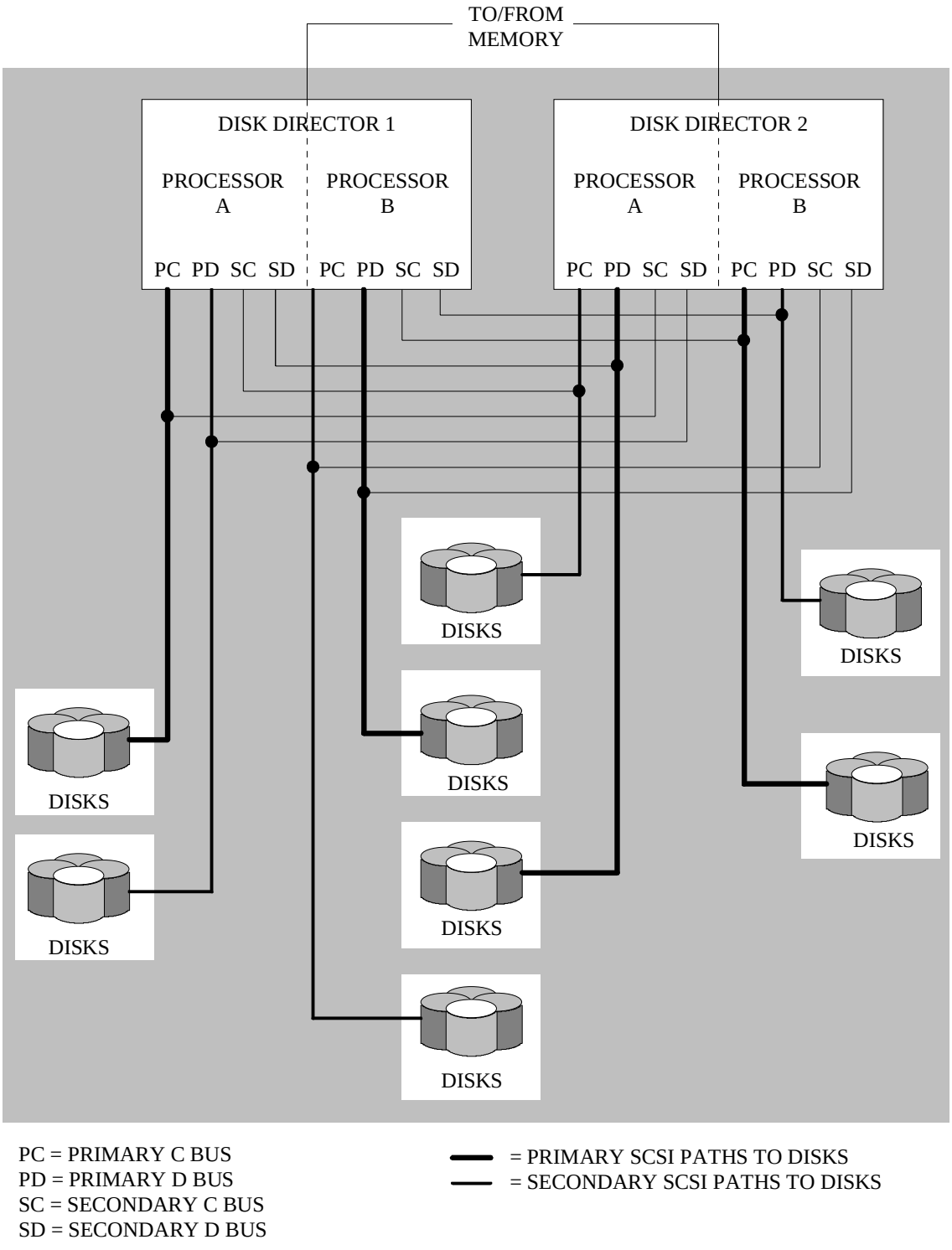


Figure 5-1. CDA 7 Dual-Initiator

In the following examples, disk director 1 and disk director 2 are paired. Each CDA 7 disk director services 16 disk devices.

EXAMPLE 1:

Disk director 1 fails. Disk director 2 automatically performs any I/O operations with all of the devices normally serviced by disk director 1 as well as all its own disk devices with no interruption in processing.

❑

EXAMPLE 2:

On disk director 1, processor A, primary SCSI bus C fails. On disk director 2, processor B, primary SCSI bus D fails. The devices of these failing buses are serviced as follows:

- The devices of failing bus C, are serviced by disk director 2, processor A, secondary SCSI bus C.
- The devices of failing bus D are serviced by disk director 1, processor B, secondary SCSI bus D.

The functioning primary buses on each of the disk directors continue to service their respective devices.

❑

EXAMPLE 3:

On disk director 2, processor A, primary SCSI buses C and D fail. The devices of these failing buses are serviced as follows:

- The devices of failing bus C are serviced by disk director 1, processor A, secondary SCSI bus C.
- The devices of failing bus D are serviced by disk director 1, processor A, secondary SCSI bus D.

The functioning primary buses of disk director 2 continue to service their respective devices.

In summary, dual-initiator provides the following advantages:

- Ensures continuous data availability if a CDA 7 disk management component fails
- Provides continuous operation by switching data pathing to the alternate disk director without interruption when a communications failure occurs with one or more disk devices
- Re-establishes normal data pathing after repair of the defective component

Dual-initiator provides an additional level of data availability in mirrored configurations. If CDA 7 is unable to read from or write to one of the devices in a mirrored pair, CDA 7 automatically uses the other disk device in the pair without interruption. If CDA 7 fails to communicate with that device also, CDA 7 then attempts to access the volume through the alternate path provided by the dual-initiator function.

❑

5.2.5 Non-disruptive Component Replacement

CDA 7, with its redundant architecture, supports non-disruptive replacement of many of its components. This includes online replacement of the directors (channel directors and disk directors), memory cards, disk devices, adapters (dual-initiator, serial), power supplies, communications cards, and cooling fans.

This non-disruptive replacement capability allows the Bull Customer Engineer to install a new component, initialize it if necessary, and bring it online without:

- Disrupting access to unaffected volumes
- Powering down the CDA 7 unit
- Stopping the operating system
- Taking unaffected channel paths offline
- Taking devices offline (other than the affected device)

This replacement must be done under controlled conditions, please contact your Bull Competence Center. For a demonstration of non-disruptive component replacement, contact your Bull Customer Service representative.

NOTE:
When replacing a Director, all activity on the director must be stopped before attempting this operation.

5.2.6 Microcode Upgrades and Loads

Microcode upgrades, performed by the Product Support Engineers (PSE) at the Bull Competence Center, allow you to take advantage of enhancements to performance algorithms, error recovery and reporting techniques, diagnostics, and microcode fixes.

It is possible to upgrade the microcode from one level to an adjacent level. Problems can happen when upgrading to a much higher microcode level.

5.2.6.1 Non-disruptive Microcode Upgrades and Loads

Non-disruptive microcode upgrades from one version to the next and interim microcode updates (loads) are available for CDA 7 systems. Symmetrix takes advantage of its multiprocessing and redundant architecture to allow for hot loadability of similar microcode platforms. Release levels can be non-disruptively loaded without interruption to user access.

During a non-disruptive microcode upgrade, the Product Support Engineer downloads the new microcode to the service processor. The new microcode loads into the EEPROM areas within the channel and disk directors and remains idle until requested for hot load in control storage. The CDA 7 system does not require manual intervention on the customer’s part to perform this function. All channel and disk directors remain in an online state to the host processor, thus maintaining application access. CDA 7 will load executable code at selected "windows of opportunity" within each director hardware resource until all directors have been loaded.

Once the executable code is loaded, internal processing is synchronized and the new code becomes operational. This capability can be utilized to upgrade or to back down from a release level or interim update.

NOTE:
During a non-disruptive microcode load within a code family, the full microcode is loaded, which consists of the same base code plus additional patches.

5.2.6.2 Dynamic Reconfigurations

CDA 7 supports dynamic reconfiguration activity without disruption to online applications, such as:

- Establish/de-establish mirrored pairs.
- Modify channel assignments.

5.2.6.3 Online SCSI-to-Fibre Channel Migration

Beginning with CDA 7 microcode revision 5265, CDA 7 systems with SCSI channel directors can be upgraded to Fibre Channel directors without taking non-SCSI channels offline and without requiring a backup and restore of data. This capability allows customers with SCSI channels to take advantage of the connectivity and distance features offered with Fibre Channel directors. Bull Customer Engineers use a new utility to perform the migration.

NOTE:
For more information on Fibre Channel migration, consult your Bull sales representative.

5.3 Data Integrity Protection

CDA 7 preserves data integrity by performing extensive error checking and correction on all data and addresses it passes internally.

5.3.1 Error Checking, Correction, and Data Integrity Protection

In conventional disk, the subsystem adds error checking and correction bytes to each data record field, as shown in the following figure. It uses these error checking and correction bytes to check the data and correct it if possible. If it detects an uncorrectable error, the disk subsystem informs the host that it has encountered bad data to avoid affecting data integrity.

Figure 5-2. Data Record Format for Conventional Disk

CDA 7, like conventional disk, performs this level of error checking and correction when it passes data and addresses. CDA 7, however, goes further to ensure that the information passed belongs to the record specified. It does this by including additional bytes with the data field of each record. These bytes contain the record ID and a double LRC (Longitude Redundancy Code) check byte as shown in the following figure. CDA 7 uses these bytes to check that the data is from the specified record and alarms the host if it is not. This second level of protection further ensures data integrity by preventing incorrect data from being transferred.

Figure 5-3. CDA 7 Data Record Format

CDA 7 has three levels of error detection. Should an error be undetected at one level, it will be detected at one of the other levels.

CDA 7 uses the following error correction and detection methods:

- Parity
- Error Checking and Correction (ECC)
- Longitude Redundancy Code (LRC)

5.3.1.1 Parity

All data and control paths have parity generating and checking circuitry that verify hardware integrity at the byte level.

5.3.1.2 ECC

The directors detect and correct single-bit and double-bit errors and report uncorrectable 3-bit or more errors in cache.

5.3.1.3 LRC

The LRC calculation further assures data integrity. The check bytes are the XOR (exclusive OR) of the accumulated bytes. Each record in memory also includes its LRC byte, its physical memory address, and block number.

5.3.2 Disk Error Correction and Error Verification

The disk directors use idle time to read data and check the polynomial correction bits for validity. If a disk read error occurs, the disk director reads all data on that track to CDA 7 cache memory. The disk director writes several worst case patterns to that track searching for media errors. When the test completes, the disk director rewrites the data from cache to the disk device, verifying the write operation. The disk microprocessor maps around any bad block (or blocks) detected during the worst case write operation, thus skipping defects in the media. If necessary, the disk microprocessor can reallocate up to 32 blocks of data on that track. To further safeguard the data, each disk device has several spare cylinders available. If the number of bad blocks per track exceeds 32 blocks, the disk director rewrites the data to an available spare cylinder. This entire process is called “error verification.”

The disk director increments a soft error counter with each bad block detected. When the internal soft error threshold is reached, the CDA 7 service processor automatically dials the Bull Competence Center and notifies the host system of errors via sense data. This feature maximizes data availability by diagnosing marginal media errors before data becomes unreadable.

5.3.3 Cache Error Correction and Error Verification

The disk directors use idle time to periodically read cache, correct single-bit errors (one hard and one soft), and write the corrected data back to cache. This process is called “error verification.” When the directors detect an uncorrectable error in cache, CDA 7 reads the data from disk and takes the defective cache memory block offline until an Bull Customer Engineer can repair it. Error verification maximizes data availability by significantly reducing the probability of encountering an uncorrectable error by preventing bit errors from accumulating in cache.

5.4 Data Protection Guidelines

The CDA 7 data protection options ensure a higher level of data protection, recoverability, and availability than the standard CDA 7 availability and reliability features. The following options can be purchased separately and implemented into the CDA 7 operation:

- Mirroring
- CDA 7 Remote Data Facility (SRDF)

The following table describes the CDA 7 data protection options. You can choose one or more of these options to match your critical data protection requirements.

Table 5-1. Data Protection Options

Data Protection Option	Description
Mirroring (RAID-1)	Provides the highest level of performance and availability for all mission critical and business critical applications by maintaining a duplicate copy of a volume on two disk devices. For more information, refer to *Mirroring*.
CDA 7 Remote Data Facility (SRDF)	Provides a disaster recovery solution by maintaining a mirror image of data in two CDA 7 systems which can be in physically separate locations. For more information, refer to SRDF.

5.5 Mirroring

Mirroring provides the highest level of performance and availability for all mission critical and business critical applications. Mirroring maintains a duplicate copy of a logical volume on two physical disk devices. CDA 7 maintains these copies internally by writing all modified data to both devices. The mirroring operation is transparent to the host.

The mirroring feature designates two logical volumes residing on different physical devices as a mirrored pair, one volume being mirror-1 and the other volume being mirror-2. The host views the mirror-1 and mirror-2 volumes as the same logical volume because each has the same unit address.

5.5.1 Write Operations with Mirroring

CDA 7 handles a write operation to a mirrored logical volume as a normal write operation. The channel director presents channel end and device end (or a good ending status) to the channel after data is written to and verified in cache. The disk directors destage the data to each logical volume in the mirrored pair maintaining the identical copies of data.

5.5.2 Read Operations with Mirroring

During read operations, if the data is not available in cache, CDA 7 reads the data from the disk pointed to by its performance algorithm for best system performance. This performance algorithm tracks path busy information as well as actuator location and what sector is currently under the disk head in each device. If a data check occurs on the device being read, CDA 7 automatically reads the data from the other device.

- **Interleave Service Policy** shares the read operations of the mirrored pair by reading tracks from both disk devices in an alternating method, a number of tracks from M1, and a number of tracks from M2. Interleave is designed to achieve maximum throughput.
- **Split Service Policy** differs from Interleave because read operations are assigned to either the M1 or the M2, but not to both.
- **Dynamic Mirror Service Policy (DMSP)** utilizes both Interleave and Split for maximum throughput and minimal head movement. DMSP adjusts each logical volume dynamically based on access patterns detected.

5.5.3 Error Recovery with Mirroring

Should one volume in the mirrored pair fail, CDA 7 automatically uses the other volume without interruption. CDA 7 notifies the Bull Competence Center of this condition. When the defective device containing the volume is replaced, CDA 7 re-establishes the mirrored pair and automatically copies data to the new disk. During the copy operation, CDA 7 gives priority to host I/O requests over copying to minimize the effect on performance. All new writes take place to both devices. The time it takes to resynchronize the mirrored pair depends on the I/O activity to the volume, the disk device, and the disk capacity.

5.5.4 Mirroring Advantages

In summary, mirroring offers the following advantages:

- Improved performance over traditional RAID 1 by supporting 100 percent fast write, and two simultaneous internal data transfer paths.
- Protection of mission-critical data from any single point of failure.
- Continuous business operation by switching to the alternate disk device of a mirrored pair without interruption to data availability should loss of access occur to one of the disk devices in a mirrored pair.
- Assurance that the second copy of data is identical to the first copy.
- Automatic resynchronization of the mirrored pair after repair of the defective volume.

5.6 SRDF for GCOS 7

The SRDF for GCOS 7 Solution is aimed at providing a complete business continuance capability during the unlikely event of a data center disaster.

SRDF for GCOS 7 is based on CDA 7 SRDF mechanism allowing for a physical remote copy of disk volumes and operating

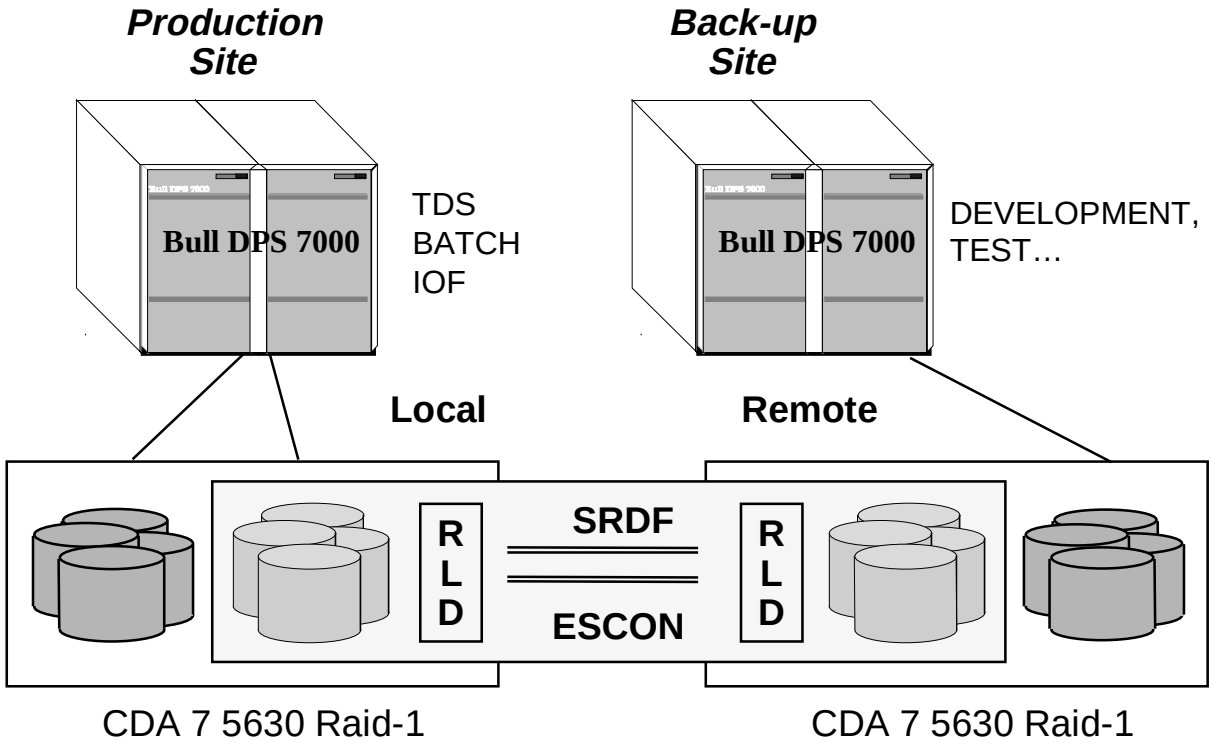
- in campus mode with ESCON-compliant fiber optics link or high speed data lines,
- in synchronous mode for a full logical synchronisation of mirrored volumes,
- with the two involved CDA 7's configured in RAID-1.

In case of disaster occuring at the Production Site, the back-up procedures entitle the Back-up Site to take over the application workload and to resume the production tasks thanks to the remote copy of user's databases and system data.

SRDF for GCOS 7

- is a very powerful solution with simple back-up procedures which are transparent for user's applications,
- avoids the need of time-consuming restore operations,
- is capable to quickly resume the business operations with minimal disruption.

SRDF for GCOS 7 is commercialized in a Project Mode. Contact your Bull Sales Engineer.



RLD = Remote Link Director

A. Power Sequences

This Appendix provides step-by-step instructions for powering the CDA 7 on and off. The unit is powered on and off via the power switches on the rear door of the unit.

- Powering Up the CDA 7
- Routinely Powering Down CDA
- Emergency Shutdown
- Powering Up After an Emergency Shutdown

A.1 Powering Up the CDA 7

DANGER:

If the CDA 7 is in need of repair, only qualified personnel familiar with safety procedures for electrical equipment and the CDA 7 should access components inside the unit.

Perform these steps to power on the CDA 7 after it has been powered off by the AC power switch.

1. Make sure all operator panel switches (channel director and disk director) are in the disable position.
2. Lift the EPO switch on the rear door to the up (|) position.
3. Lift the AC power switch on the rear door to the up (|) position. The CDA 7 begins its IML procedure. This procedure takes several minutes to perform.

NOTE:

The power controls are inoperative unless the Emergency Power Off (EPO) switch on the rear door is in its enabled (up, | position). The EPO switch when turned off (down, O position) disables all power to CDA 7 including the backup battery systems.

4. When the IML procedure completes (all directors show "0F" in their LED displays on their front panels), place the operator panel switches (channel director and disk director) in their enable position.

   When "0F" clears from all director LED displays, the CDA 7 is then available to the host system(s).

A.2 Routinely Powering Down CDA

Perform these steps to power off the CDA 7 using the AC power switch.

1. Stop all processes to the CDA 7.
2. Watch the operator panel and wait for all "Active" LEDs to stop flashing.

NOTE:
The displays stop flashing when the CDA 7 has written all cache data to disk.

3. Press the AC power switch on the rear door to the down (O) position.

NOTE:
The battery backup system automatically turns on when the CDA 7 detects loss of AC power. The battery will keep the CDA 7 powered for 3 minutes following which CDA 7 turns off.

A.3 Emergency Powering Down

If it becomes necessary to power off the CDA 7 immediately:

• Press the red EPO switch on the rear door to the down (O) position.

NOTE:
CDA 7 immediately switches to backup battery power and destages any pending writes in cache to disk. This destage operation takes approximately 20 seconds following which CDA 7 powers down.

IMPORTANT:
When there is an emergency power cut, data in the cache might not be saved on the physical disks.

A.4 Powering Up After an Emergency Shutdown

CAUTION:
This unit contains no user-serviceable parts, so it should not be opened for any reason by untrained personnel. If the CDA 7 is in need of repair, only qualified personnel familiar with safety procedures for electrical equipment and the CDA 7 should access components inside the unit.

When the CDA 7 is powered down via the red EPO switch, a breaker switch on the power subsystem trips.

Perform these steps to power on the CDA 7 after it has been powered off by the red EPO switch.

CAUTION:
Always contact the Bull Customer Support Center prior to powering up the CDA 7 after an emergency shutdown.

1. Make sure all operator panel switches (channel director and disk director) are in the disable position.
2. Lift the EPO switch on the rear door to the up (|) position.
3. Lift the AC power switch on the rear door to the up (|) position.

NOTE:
The CDA 7 begins its IML procedure. This procedure takes several minutes to perform.

4. When the IML procedure completes, all directors show "0F" in their LED displays.

CAUTION:
Before you enable channel and disk directors from the CDA 7 operator panel, contact an EMC Product Support Engineer from the EMC Customer Support Center. Explain that an emergency shutdown was performed and that you need them to check the condition of the CDA 7 before you enable the channel and disk directors. When the CDA 7 checks out correctly, proceed to the next step.

5. Place the operator panel switches (channel director and disk director) in their enable position.

   When "0F" clears from all director LED displays, the CDA 7 is then available to the host system(s).

B. ESP Installation Requirements

This Appendix covers the tasks you need to perform when planning or verifying the physical configuration of CDA 7 in your system or creating I/O addressing schemes.

B.1 CDA 7 Hardware Checklist

Make sure you discuss with and obtain the following site profile information with the Customer Engineer and/or Systems Engineer. This information is necessary for each CDA 7 subsystem you are installing (following table).

Table B-1. CDA 7 Host Checklist

CDA 7 Model	
Total number of physical drives to be configured on the CDA 7	
Physical drive type (size)	
Total amount of CDA 7 cache	
Number of SCSI channel or Fibre channel directors	
Ultra channel director model used	
Number of Ultra channels used per director	
Fibre channel director model used	
Number of fibre port used per director	

B.2 Open Checklists for ESP Connection

Make sure you discuss with and provide the following host information to the Customer Engineer and/or Systems Engineer. This information is necessary for each host you are attaching to the CDA 7 subsystem. Make a copy of this form for each host you will attach to CDA 7. When you are done you should have a checklist for each host.

Table B-2. Open System Server Host Checklist (1/2)

Host Configuration Requirements	Host 1	Host 2
Host (CPU) vendor and model number		
Host controller type and model number		
Memory capacity of host		
O/S revision level of host		
I/O rate per second expected per host		
SCSI adapter used on host, type and model number		
Is this a clustered environment? Which one?		
Will devices be shared? Which ones?		
Total number of SCSI channels per host, to which SA ports will they attach?		
Total number of Fibre channels per host, to which FA ports will they attach ?		
Specify if any narrow channels used		
Number of logical devices needed per SCSI bus		
Size of volumes required to be visible to host[1]		
Total customer usable data storage required		
Will host-level mirroring be used, which volumes?		
Will CDA 7 Dynamic Sparing (specify number of spares) be used, which volumes?		
Will CDA 7 RAID-1 be used, which volumes?		
Will SRDF be used, which volumes?		
Data storage utilization per host[2]		
Average transfer size of data		
Using raw devices or filesystems?		
Size of filesystem		

Table B-2. Open System Server Host Checklist (2/2)

Host Configuration Requirements	Host 1	Host 2
Will data stripping be used? What type of data stripping package?		
Partitioning?		
Partition sizes?		
LVM used[3]		
What major applications are to be run?		
Database used: Oracle®/Sysbase®/Informix®/other?		
Size of database		
Database release version		
Supply typical high level database schema and queries		
Any patches or modifications related to IO/SCSI?		
Additional comments		

NOTES:

1. This is the volume size needed for each volume visible on the SCSI bus.
2. Percentage of available CDA data capacity used by that host.
3. Special attention is required when using a Logical Volume Manager (LVM) and/or data stripping when using hyper-volumes.

B.3 SCSI Cable Worksheet

The physical connection to a Ultra channel interface occurs at the connectors on the SCSI adapters located at the rear of the CDA 7 unit.

When connecting to hosts with differential Ultra or differential narrow SCSI interfaces, use differential P-cables that are designed for wide SCSI applications (see labeling on cable).

NOTE:
For a list of the Ultra SCSI cables available from Bull, refer to the manual *CDA 7 Site Preparation*. You can use the following table as a cable worksheet form.

Table B-3. Cable Worksheet

SCSI Director	SCSI Director Port	Cable Length Required	Cable Model Number or Part Number	Host ID Model Number
1A	a			
1A	b			
1B	a			
1B	b			
2A	a			
2A	b			
2B	a			
2B	b			
3A	a			
3A	b			
3B	a			
3B	b			
4A	a			
4A	b			
4B	a			
4B	b			

B.4 ULTRA SCSI Channel Adapters

Several Fast-Wide / Ultra SCSI adapters are available in CDA 7, depending on the host channel connection requirements, such as terminated and non-terminated channels, and Y-cable cluster configurations.

NOTE:
Contact your Bull Sales Representative to obtain SCSI adapter part numbers. For cluster configurations, refer to the *Symmetrix High Availability Environment Product Guide*.

B.5 SCSI Cable Precautions

When connecting CDA 7 Ultra SCSI channels to host channels it is important to know CDA 7 Ultra SCSI hardware components and their channel designations.

Each Ultra SCSI director occupies one slot on the CDA 7 backplane. Each director interfaces to the host channels via a SCSI adapter connected to the opposite side of the backplane.

The Ultra SCSI director contains two advanced microprocessors. Each microprocessor has two wide-differential SCSI channels. The following figure illustrates this interface and the channel designations.

NOTE:
When connecting the CDA 7 SCSI cables to the host channels, notice that the "A" processor channels are on the bottom and the "B" processor channels are on the top.

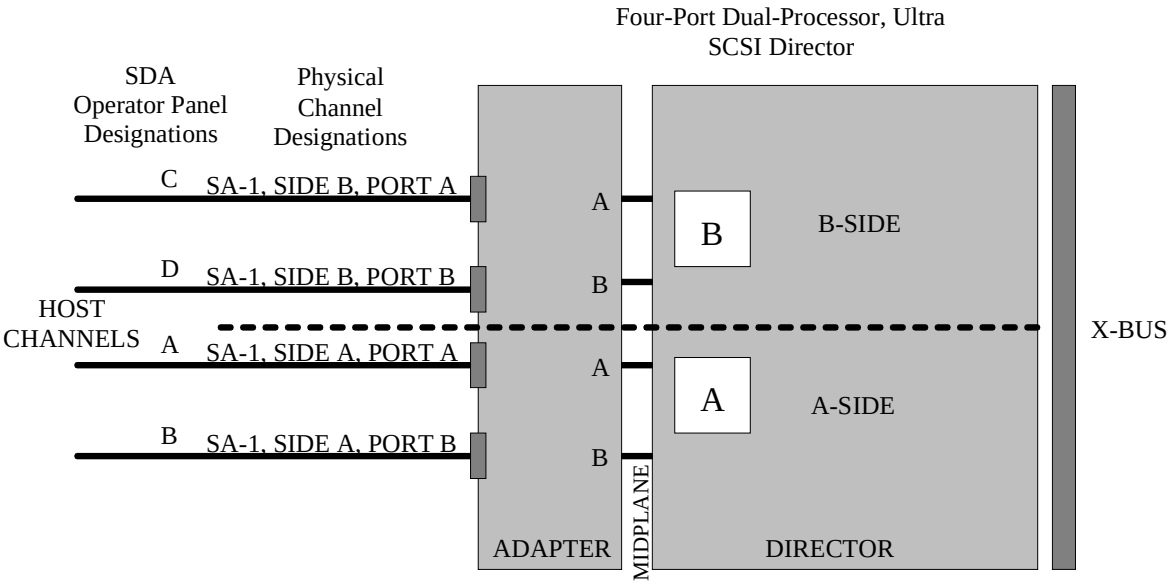


Figure B-1. Ultra SCSI Director Channel Designations

Additional Precautions

Observe the following precautions when connecting SCSI cables to the CDA 7 SCSI channel interface connectors:

- Use the shortest cabling possible between the CDA 7 unit and the host.
- Always check for bent pins on the SCSI cables before connecting them. The SCSI cable pins bend very easily.
- Always attach SCSI cables to their connectors straight on to minimize the chance of bending pins.
- The pin shroud on the SCSI cable ends deforms easily. Take care not to drop cable ends or bang them against objects.
- When attaching the SCSI cable to the connector on the SCSI adapter in the CDA unit, remember to fasten the screws on the connector to ensure a secure connection.
- When connecting to hosts with differential Fast-Wide SCSI interfaces, do not allow the cable length to exceed 82 feet (25 m).
- When connecting to hosts with Ultra SCSI interfaces, do not allow the cable length to exceed 62 feet (19 m).
- Fibre Channel interfaces extend connectivity up to a maximum of 1600 feet (500 meters).

Glossary

This glossary contains terms related to disk storage subsystems. Many of these terms are used in this manual.

A

Actuator
A set of access arms and their attached read/write heads, which move as an independent component within a head and disk assembly (HDA).

Adapter
Card that provides the physical interface between the director and disk devices (dual-initiator adapter), director and parallel channels (Bus & Tag adapter), director, serial channels (serial adapter), and SCSI host channels (SCSI adapter).

ADT
Automatic Diagnostic Test.

Alternate Track
A track designated to contain data in place of a defective primary track. See also Primary Track.

ANSI
American National Standards Institute. A standards-setting, non-government organization which develops and publishes standards for voluntary use in the USA.

Asynchronous Transmission
A handshaking protocol that requires each byte be requested and acknowledged before the transmission of the next byte begins.

B

Backplane
Card that accommodates the director, cache, and adapter cards.

Bit
The smallest unit of computer memory. A bit can hold a value of 0 or 1.

Byte
Term that indicates an 8-bit hexadecimal construction.

C

Cache
Random access electronic storage used to retain frequently used data for faster access by the channel.

Cache Slot
Unit of cache equivalent to one track.

Channel Director
The component in the Symmetrix subsystem that interfaces between the host channels and data storage. It transfers data between the channel and cache.

Command Descriptor Block (CDB)
The structure used to communicate commands from an initiator to a target. This structure may be 6 bytes, 10 bytes, or 12 bytes in size.

D

Data Availability
Access to any and all user data by the application.

Delayed Fast Write
There is no room in cache for the data presented by the write operation. Therefore, the write is delayed until there is room in cache.

Destage
The asynchronous write of new or updated data from cache to disk device. See also the term "Stage".

Device
A uniquely addressable part of the Symmetrix subsystem that consists of a set of access arms, the associated disk surfaces, and the electronic circuitry required to locate, read, and write data. See also Volume.

Device Number
The value that logically identifies a disk device in a string.

Diagnostics
System level tests or firmware designed to inspect, detect, and correct failing components. These tests are comprehensive and self-invoking.

Differential Interface
An electrical signal configuration that uses a pair of lines for transfer. This configuration (as compared to a single-ended interface) has a higher tolerance for common-mode noise and little crosstalk when used with twisted pair cables. It supports cables lengths to 25 meters (82 feet). See also Single-ended Interface.

Directors
The components in the Symmetrix subsystem that allows Symmetrix to transfer data between the host channels and disk devices. See also Channel Director and Disk Director.

Disk Director
The component in the Symmetrix subsystem that interfaces between cache and the disk devices.

DMA
Direct Memory Access.

Dual-Initiator
A Symmetrix feature that automatically creates a backup data path to the disk devices serviced directly by a disk director, if that disk director or the disk management hardware for those devices fails.

Dynamic Path Reconnect (DPR)
A function that allows disconnected I/O operations with Symmetrix to reconnect over any available channel path rather than be limited to the one on which the I/O operation was started.

Dynamic Sparing
A Symmetrix feature that automatically transfers data from a failing disk device to an available spare disk device without affecting data availability. This feature supports all devices in the Symmetrix subsystem and is used with the Mirroring and SRDF options.

E

EPO
Emergency Power Off.

Error Verification
The process of reading, checking the error correction bits, and writing corrected data back to the source.

ESP
Enterprise Storage Platform. Symmetrix ESP is a functional enhancement that allows simultaneous storage and access of mainframe data and open systems data on the same Symmetrix 53xx system.

F

Fast Write
In Symmetrix, a write operation at cache speed that does not require immediate transfer of data to disk. The data is written directly to cache and is available for later destaging.

FBA
Fixed Block Architecture. Disk device data storage format using fixed size data blocks.

Fibre channel
Fibre channel speeds up to 100 MB/sec.

Field Replaceable Unit (FRU)
A component that is replaced or added by service personnel as a single entity.

G

Gigabyte (GB)
10^9 bytes.
The GB_2 value is based on the convention: 1 GB = 1024x1024x1024 bytes.
The GB_{10} value is based on the convention: 1 GB = 1000x1000x1000 bytes.

H

HACMP
High Availability Clustered Multiprocessing.

Head and Disk Assembly (HDA)
A field replaceable unit in the Symmetrix subsystem containing the disk and actuator.

I

ICDA
Integrated Cached Disk Array.

ICKDSF
See Device Support Facilities program.

Identifier (ID)
A sequence of bits or characters that identifies a program, device, controller, or system.

IML
Initial microcode program loading.

Index Marker
Indicates the physical beginning and end of a track.

Index Point
The reference point on a disk surface that determines the start of a track.

IOCP
Input/Output Configuration Program.

I/O Device
An addressable input/output unit, such as a disk device.

IPL
Initial Program Loading.

K

Kilobyte (K)
1024 bytes.

L

Least Recently Used Algorithm (LRU)
The algorithm used to identify and make available the cache space by removing the least recently used data.

Logical Unit
A physical or virtual device addressable through a target. A physical device can have more than one logical unit.

Logical Unit Number (LUN)
An encoded three-bit identifier for the logical unit.

Logical Volume
A user-defined storage device. In the Symmetrix subsystem, the user can define a physical disk device as one to eight logical volumes.

Logical Volume Manager (LVM)
The part of the AIX system responsible for disk subsystems. Interaction with the LBM is done via SMIT menus or via stand-alone commands.

Long Miss
Requested data is not in cache and is not in the process of being fetched.

Longitude Redundancy Code (LRC)
Exclusive OR (XOR) of the accumulated bytes in the data record.

M

Media
The disk surface on which data is stored.

Megabyte (MB)
The MB_2 value is based on the convention: 1 MB = 1024x1024 bytes.
The MB_{10} value is based on the convention: 1 MB = 1000x1000 bytes.

Mirrored Pair
A logical volume with all data recorded twice, once on each of two different physical devices.

Mirroring
The Symmetrix option that maintains two identical copies of a designated volume on separate disks. Each volume automatically updates during a write operation. If one disk device fails, Symmetrix automatically uses the other disk device.

P

Physical Partition (PP)
A physical partition is the smallest unit of disk space that can be allocated in a volume group in an AIX environment. Any disk space allocated is an integral number of physical partitions. By default, a PP is 4 MB in size.

Primary Track
The original track on which data is stored. See also Alternate Track.

Promotion
The process of moving data from a track on the disk device to cache slot.

R

Read Hit
Data requested by the read operation is in cache.

Read Miss
Data requested by the read operation is not in cache.

Reconnect
The function that occurs when a target selects an initiator to continue an operation after a disconnect.

Reconnection
A reconnection exists from the assertion of the BSY signal in a RESELECTION phase until the next BUS FREE phase occurs. A reconnection can only occur between a target and an initiator.

Record Zero
The first record after the home address.

Reselect
The function that occurs when a target disconnects from an initiator in order to perform a time-consuming function and, then after performing that function, reestablishes the connection.

Reserved
The term used for bits, bytes, fields, and code values that are set aside for future standardization.

S

SCSI
Small Computer System Interface.

SCSI Adapter
A circuit board used to interface the SCSI bus with an internal bus. Used in this manual to identify the Symmetrix SCSI Adapter that interfaces the SCSI bus from the host(s) to the Symmetrix SCSI Channel Director. Symmetrix SCSI Adapters, located in the rear card cages, have four SCSI connectors for attaching cables from the hosts(s).

SCSI Address
The octal representation of the unique address (0-7) assigned to a SCSI device. This address would normally be assigned and set in the SCSI device during system installation.

SCSI Device
A host computer adapter or peripheral controller or intelligent peripheral that can be attached to the SCSI bus.

SCSI ID
The bit significant representation of the SCSI address referring to one of the signal lines DB(7-0).

Short Miss
Requested data is not in cache, but is in the process of being fetched.

Single-ended Interface
An electrical signal configuration that uses a single line for each signal and references a ground path common to the other signal lines. The single-ended configuration is susceptible to common mode noise and has a maximum cable length of 6 meters. See also Differential Interface.

SIO
Start I/O.

SRDF
Symmetrix Remote Data Facility. SRDF consists of the microcode and hardware required to support Symmetrix remote mirroring.

SRDF for GCOS 7
This is a disaster recovery solution that maintains a mirror image of data in two CDA 7 5330-23 subsystems that are located in physically separate sites.

Stage
The process of writing data from a disk device to cache. See also the term "Destage".

Storage Control Unit (SCU)
The component in the Symmetrix subsystem that connects Symmetrix to the host channels. It performs channel commands and communicates with the disk directors and cache. See also Channel Director.

Striping
The process of segmenting logically sequential data and writing the segments to multiple physical disk devices.

Synchronous Transmission
A timing protocol that uses a master clock with a clock period and allowable offset that holds the sending and receiving devices in the desired phase relationship.

T

Target
A SCSI device that performs an operation requested by an initiator.

Terabyte
The TB_2 value is based on the convention: 1 TB = 1024x1024x1024x1024 bytes.
The TB_{10} value is based on the convention: 1 TB = 1000x1000x1000x1000 bytes.

U

ULTRA SCSI
Ultra SCSI (Small Computer Systems Interface). The transmission rate is 20 MB/s in 8 bit format and 40 MB/s in 16 bit format.

UNIX
UNIX is an interactive, multi-tasking, multi-user operating system. UNIX is written in “C” language. There are three types of UNIX files: directories, data files, and special files. A directory is a file containing certain information about another file. A directory contained within another directory is a sub-directory. The two most common types of UNIX are BSD (Berkeley Software Distribution) and System VR4 (developed by AT&T). Most UNIX systems are a “mix” of both types.

V

Volume
A general term referring to a storage device. In the Symmetrix subsystem, a volume corresponds to single disk device.

W

WSP
Wide SCSI Processor.

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